THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 33. Thursday, April 29, 1926. No. 506.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of
THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Telephone: 6611 Gerrard (2 lines).
Telegrams: Zacatecas, Westrand, London.

Contents.

	PAGE
The Educational Value of Foundry Conventions	325
Correspondence	326
Rustless Iron	328
Institute of British Foundrymen	328
Aluminium Foundry Practice	329
Patent Specifications Accepted	332
Some Further Notes on Pearlitic Cast-Iron—Part II	333
Machine Plate Moulding Practice	336
Moulding a Still in Loam	337
New Companies	338
Fireclay Bricks	339
Notes on Annealing Brass	341
Company Meetings	342
Contracts Open	342
Company Reports	342
Obituary	344
Iron and Steel Markets	346

Forthcoming Events.

MAY 1.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Refractories in the Foundry," Paper by H. V. Grundy and A. Phillips.

MAY 6-7.

Iron and Steel Institute:—Annual meeting in London. Papers for discussion:—Report on "Heterogeneity of Steel Ingots" by Dr. W. H. Hatfield (Chairman), T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M. Service and J. H. Whiteley; "A Note on the Distribution of Silicates in Steel Ingots," by J. H. S. Dickenson; "Ghost Lines and Banded Structure of Rolled and Forged Mild Steels," by J. H. Whiteley; "Magnetic Changes in Iron and Steel below 400 deg. C.," by W. H. Dearden and C. Benedicks; "Coal Blending," by D. Brownlie; "Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast Furnace," by W. W. Hollings; "Effect of Mass in the Heat Treatment of Nickel Steel," by W. Rosenhain, R. G. Batson and N. P. Tucker; "Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters," by G. R. Woodvine and A. L. Roberts.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1925-26: John Cameron, Kirkintilloch, near Glasgow.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield: R. Village, "Bircholme," Dronfield, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.
East Midlands: K. Bunting, 17, Marcus Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 183, Moorside Road, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

The Educational Value of Foundry Conventions.

The Technical Advisory Committee of International Foundry and Allied Trades' Exhibition has been at work during the last few months preparing what will undoubtedly be the finest non-commercial exhibit ever shown to the British industry. The exhibit is divided into a number of separate tables, and each table is allotted to some organisation or type of exhibit. Amongst those who are being responsible for a section are the National Physical Laboratory, Woolwich Research Department, the British Cast Iron Research Association, Verein Deutscher Eisengiesseien Gresseiverband, and the Universities of Sheffield, Birmingham, Manchester and Wales. The London foundries are also co-operating by sending along samples of the castings, both good and bad. Finally, the majority of the scientific instrument manufacturers are also co-operating. Being devoid of all commercial aspect, such a stand will be free from all the artifices of advertisement. It is on this account that we seek the co-operation of the various foundry directorates, owners and managers to impress upon the more practical men they no doubt intend sending, to spend as much time as possible at this particular stand. There will be a number of competent metallurgists in charge, who will be only too pleased to explain the use of the microscope, the meaning of a Brinell number, or the utilisation of a pyrometer. The main object of those responsible has been to assemble a series of representative apparatus and samples, so that the practical man can handle the chemist's tools and thus be in a position to understand much more clearly the figures which so profusely illustrate the articles in the technical Press.

Another educational aspect of the Convention is the number of works' visits which have been arranged. Altogether there are 14 works which are opening their doors. As some of the works are only quite small, the number of visitors is necessarily limited. Thus it cannot possibly be guaranteed that any but the first-comers can be accommodated. It is essential that the reply forms which will be sent out in the course of the next few days should be returned as soon as possible. Here again we appeal to the "men that matter" to help the Committee, by making up their minds as to allowing leave to their staff who are members of the Institute as soon as possible, so that they may be assured of visiting the works which interest them most.

A third educational aspect of the Convention is that of the technical sessions, where papers are given by the world's most famous foundry authorities and are discussed from both the academic and practical aspects. It is an education in itself for the young foundryman to rub shoulders with the people who are at present dominating the technical thought of the industry.

Finally, there is the Exhibition itself, wherein is being shown the latest types of machinery and supplies for the economic conduct of the industry. The foundrymen who, to quote Monsieur Ronceray, have learnt "how to see," will assimilate more useful knowledge in the few days at the Conference than a whole session at what is known in the provinces as "night schools." It should be clearly understood that this is not meant in any disrespectful way, it being one of our firmly-rooted convictions that knowledge assimilated under such pleasant circumstances leaves a more lasting impression, probably owing to the separation from actual everyday life being a little wider in the academic sense and a little closer in the practical sense.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Hot Spots.

To the Editor of The Foundry Trade Journal.

Sir,—The analogy drawn in your editorial of March 4 between the "piping" of steel ingots and the cavities found in the interior of the heavy sections of a grey iron casting is extremely interesting.

As an experiment we filled one of our ordinary cast-iron piston moulds full of cast iron, omitting the core. We thus got a very solid chunk of cast iron, which would correspond to the "hot spots" described in your editorial. This was free, however, from cavities. With the same iron and with the same size mould in sand we got a casting corresponding to the "hot spots" discussed with the characteristic cavities.

The illustrations in Fig. 2 show not only the cavities in the one casting and their absence in the other, but they also show a depression in the upper portion of the casting cast in sand, whereas in the case of the casting cast in cast iron the iron is squeezed up giving a convex surface to the upper end of the mould.

Now the explanation I offer is that when grey iron freezes it expands, as is well known, just as water expands when it freezes. This results in the structure being more dense when the iron is cast in an iron mould, even although the iron mould is heated, for the reason that the rate of solidification is sufficiently rapid so that the interior of the casting is trapped in a relatively solid outer wall and thus subjected to considerable internal pressures and resulting in a convex surface on the upper portion of the casting.

When pouring into a cold sand mould a thin shell is immediately formed, the interior then gradually cools, and as it cools expands and thus stretches the thin outer wall which, of course, is only supported by the sand. The interior then cools and ultimately shrinks away from the outer wall, producing cavities.

As I understand it, in the pearlitic method the rate of freezing is so slow that the whole casting may be said to freeze together, in which case, of course, you would get just as solid a casting as you would by pouring into a metal mould and utilising the interior pressure created by the sudden freezing.

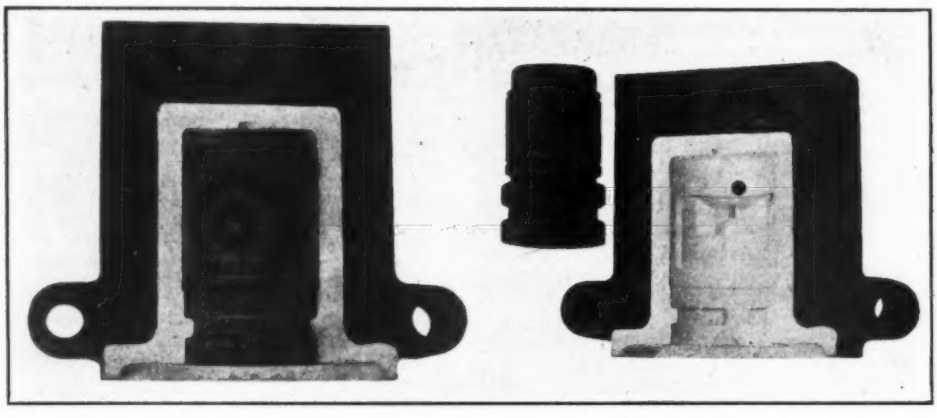


Fig. 1.—Type of Mould used for Casting the Block shown on the Right of Fig. 2.

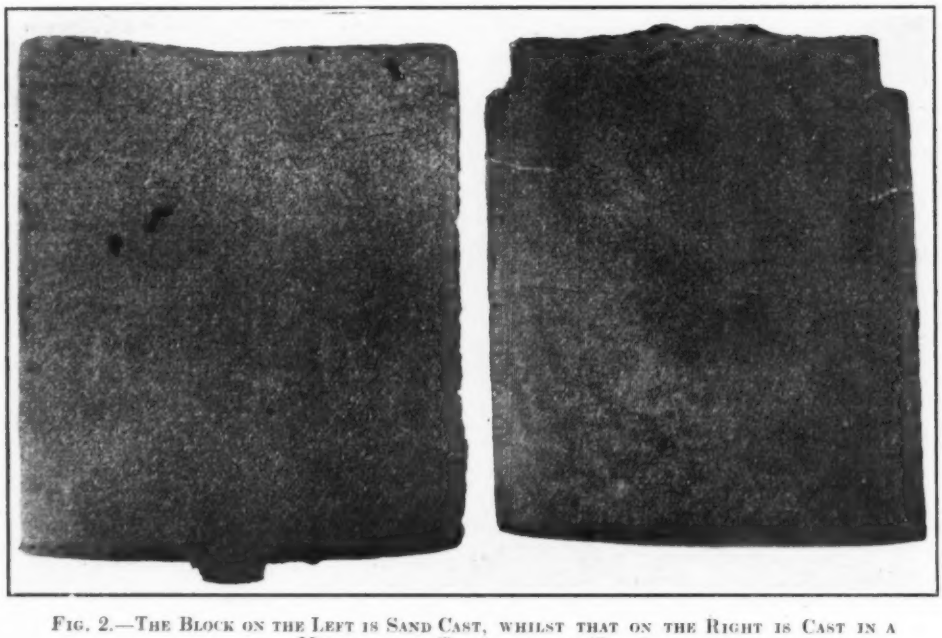


Fig. 2.—The Block on the Left is Sand Cast, whilst that on the Right is Cast in a Mould of the Type shown in Fig. 1.

What makes this interesting is that both an accelerated and a decelerated rate of cooling, as compared with an ordinary sand mould, produces more solid castings.

Yours, etc.,

G. M. Udale,
A.M.Inst.C.E., B.Sc., LL.B.

Holley Carburetor Company,
Detroit, Michigan, March 31.

Electric Furnace Practice.

To the Editor of The Foundry Trade Journal.

Sir,—I have noted with interest the letter appearing in your issue of April 15 subscribed by G. M. G., and referring to my Paper given before the Lancashire Branch some little time ago.

The writer of the letter appears to have noticed a similar phenomenon, and associated it with the use of unusually rusty scrap. It is very likely that this factor is an important one, and I would inform G. M. G. that the method used to minimise the occurrence of this trouble was the taking of precautions to prevent an over-oxidised low-carbon metal resulting at the end of the melting period.

I am in agreement with the statement that the trouble is associated with the action of intense local temperature in the neighbourhood of the electrodes on a highly oxidised material. The point was raised, however, in order to show the possibility of some stable formation of oxidation not susceptible to the normal action of deoxidising materials.

In all cases during the period in question no samples were permitted to be taken in chill moulds, as I agree with the writer that such samples are not a true guide to the behaviour of the steel when afterwards poured into sand moulds. The samples were taken in a wide spoon carefully slag-lined, and allowed to remain uncovered in the spoon until solidified. The suggestion made by the writer, of pricking the skin formed on the surface as the sample cools, is, however, of considerable interest, and no doubt is an even more severe test.

The statement made in the last paragraph that the writer can, from his material, produce *all* perfectly sound castings should inspire the English manufacturer to redouble his efforts, as one must admit, with regret, that this state of affairs is not the happy lot of most of us.

I would, finally, express my thanks to G. M. G. for his very useful and interesting contribution to this discussion.—Yours, etc.,

F. A. Melmoth.

The Châlet, Ivy Park Road, Sheffield.
April 21, 1926.

Provisional Protection for Inventions.

To the Editor of The Foundry Trade Journal.

Sir,—The British patent system, while being, in the opinion of the writer, admirable, with its system of provisional protection, yet gives rise to some rather curious situations which to some extent detract from the benefit conferred upon an inventor.

The main object of filing a provisional application for the protection of an invention, is to secure temporary protection pending the consideration of the value and commercial prospects of the invention. If these should prove unsatisfactory, then the application can be abandoned, otherwise a complete specification is filed with a view to securing Letters Patent on the application.

The grant of a Patent confers on the patentee the exclusive right to make, use, exercise and vend the invention. Pending the grant of a Patent on an application it is customary and advisable to mark the invention with the words "Patent applied for" or "Provisionally protected" and this is often sufficient to deter infringement.

While an inventor is provisionally protected from the date of the filing of his application, yet infringers cannot be sued until after a Patent is sealed on the application, and then they can only be sued for infringements committed after the *acceptance* of the complete specification. This is a fact which is not generally known. Now, a complete specification may be accepted at any time up to fifteen months from the date of the application, or with fine up to eighteen months. In the wireless industry, a large number of useful and patentable devices are being invented every week and consequently the division of the Patent Office which deals with this class of invention is very busy indeed with the examination of complete specifications. This examination, among other things, includes a very lengthy search among prior British Complete Patent Specifications relating to the art, and, in many cases, several months might elapse before the acceptance of complete specifications of wireless devices can be obtained even though every effort is made to expedite the cases.

Now, take the case of an inventor who invents, say, a wireless device. He files an application for a patent accompanied by a provisional specification. Some two months afterwards he may find that a large manufacturer is turning out articles which would be an infringement of his patent if granted. What remedy has he? The manufacturer may have, and in all probability has, come by the invention quite legitimately. The inventor, at the moment, has no remedy, for the reason that he is not entitled to institute any proceeding for infringement until a patent for his invention has been granted to him. He can, however, file his complete specification straightaway and use every endeavour to expedite the acceptance of the same. But he would probably not obtain the acceptance until several months had elapsed after the filing of his complete specification, and so he cannot sue on any articles which are made during that period. He can go to the manufacturer and explain that he has provisional protection for the device and offer to sell his invention to the manufacturer or to grant him a licence. In some cases, the manufacturer may agree to pay royalties at this stage. If he does so, the inventor should consider himself fortunate.

Thus, we see that until the Complete Specification is accepted the inventor is practically helpless against the manufacturer.

In an action for the infringement of a Patent that came before the Court in 1890, proof was given of the use of the invention, in the interval between the filing and acceptance of the Complete Specification, and also subsequent to the commencement of the action. The Court held that as the first infringement was before the acceptance of the Plaintiffs' Specification, there was no actionable infringement, and therefore damages could not be awarded, but as there was evidence of an intention to infringe the Patent the Court granted an injunction restraining the infringement of the Patent.

It will, therefore, be seen that while provisional protection is a very great benefit to the inventor, yet it also has its disadvantages.—Yours, etc.,

H. T. P. Gee.

51 and 52, Chancery Lane,
London, W.C.2.

Britain's Largest Ironfoundry.

To the Editor of The Foundry Trade Journal.

Sir,—With regard to "Interested's" letter in your issue of April 15 asking as to what is "Britain's largest Ironfoundry," the writer thinks that the question is much too wide.

Thus, Messrs. Harland & Wolff, Limited, Govan, have one shop 1,200 ft. long and 600 ft. broad, but as their product is Diesel engine and general ship work, the production per square yard of floor space must necessarily be low. A shop employed on railway chairs or pipes need only have a quarter of Messrs. Harland & Wolff's space to give a much larger output.

The writer is presently in charge of a shop producing 15,000 tons of castings per annum. This is about 60 per cent. of the capacity of the shop, and the shop is 270 ft. long × 60 ft. wide. The product is principally ingot moulds and similar castings.

To arrive at any understanding as to what constitutes "Britain's largest Ironfoundry," it would be necessary to know:—

1st. The size of the shop.
2nd. The class of casting produced.
3rd. The quantity of castings produced.

Yours, etc.,

Cupola.

[On a weight basis probably the Stanton Ironworks Company is the largest.—Editor.]

Painting Castings.—For cast-iron plates and other plain surface castings, 10 lbs. of mixed red lead paint will cover approximately 54 superficial yards. This allows for a good solid coat sufficient for the average estimating purposes.

Rustless Iron.

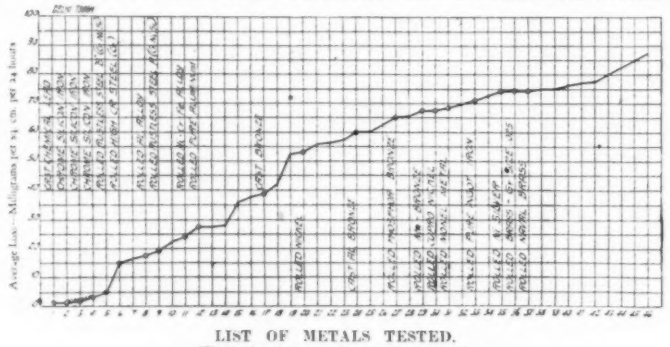
A new "rustless iron" has been produced by an American steel company, and, though the exact analysis remains a secret, the metal is low in carbon (averaging 0.07 per cent.), high in silicon, and high in chromium. It cannot be hardened by heat treatment, as there is not sufficient carbon present to enable this alloy iron to be hardened, so that its application is limited to the soft, or annealed, condition. It is claimed to be more rustless than any alloy iron yet produced, and will withstand the action of weather, salt water and mine waters. It is also resistant to nitric acid. It is easily forged, and, when annealed, can be machined almost as readily as screw machine stock.

The ductility of this alloy is said to approach that of iron, though it has a 50 per cent. higher ultimate strength and elastic limit. The modulus of elasticity is approximately 27 millions. A bolt made of this material will withstand two-and-a-half times the load generally considered safe with bronze, and it is equally non-corrosive, except in the case of acids such as hydrochloric and sulphuric.

The metal is non-corrodible and non-oxidisable when heated to temperatures not in excess of 980 deg. C., and it can be held at this temperature for months without any perceptible scale forming on the surface other than a slight bronzing effect. This alloy cannot be cut by the oxy-acetylene torch, as the impinging oxygen has the effect of blowing the heated surface cold again without material oxidisation. It can, however, be readily oxy-acetylene welded, and the filler rod, if used, should be of the same material. The alloy has been christened "Delhi Tough," and some comparative tests carried out with it in conjunction with other metals at the Carnegie Institute of Technology are summarised in the chart. All the metals and alloys were tested under identical conditions in an accelerated electrolytic test in which the electrolyte was acid mine water.

The writer is indebted to the Ludlum Steel Company, of Watervliet, New York, for the chart of comparative tests.

RESULTS OF ACCELERATED CORROSION TEST IN ACID MINE WATER



LIST OF METALS TESTED.
With Numbers as shown in Diagram.

1, Cast chemical lead; 2, Rolled Chrome-silicon iron; 3, Cast chrome-silicon iron; 4, Rolled chrome-silicon iron; 5, Rolled rustless steel "B"; 6, Rolled high chromium steel; 7, Cast aluminium-silicon alloy; 8, Rolled aluminium alloy; 9, Rolled rustless steel "A"; 10, Cast aluminium-manganese alloy; 11, Rolled nickel-chromium-iron alloy; 12, Rolled pure aluminium; 13, Rolled nichrome; 14, Rolled aluminium manganese alloy; 15, Cast leaded bronze; 16, Cast leaded zinc bronze; 17, Cast bronze; 18, Cast leaded bronze; 19, Cast copper-lead alloy; 20, Rolled nickel; 21, Cast tin-lead-nickel silver; 22, Cast leaded cupro-nickel; 23, Cast silicon-nickel silver; 24, Cast aluminium bronze; 25, Rolled iron-aluminium bronze; 26, Cast iron-manganese cupro-nickel; 27, Rolled phosphor bronze; 28, Cast chromium iron cupro-nickel; 29, Rolled manganese bronze; 30, Rolled cupro-nickel; 31, Rolled monel metal; 32, Rolled cupro-nickel (coin metal); 33, Rolled pure ingot iron; 34, Rolled copper-manganese-iron alloy; 35, Rolled nickel-silver; 36, Rolled brass Gr. size, 0.025 mm; 37, Rolled naval brass; 38, Rolled bronze; 39, Rolled brass Gr. size, 0.035 mm; 40, Rolled zinc phosphor bronze; 41, Cast tin-lead-nickel silver; 42, Rolled low brass; 43, Rolled brass Gr. size 0.075 mm; 44, Rolled iron-nickel silver; 45, Rolled high brass; 46, Rolled nickel silver.

To Prevent Soft Solder from Spoiling.—After prolonged heating, solders and other alloys of lead and tin are liable to become thick, owing to the presence of occluded oxides, and particularly when overheating has taken place. To make the metal suitable for work use 10 per cent. phosphor-tin at the rate of from 0.5 to 1.5 per cent., according to the state of the metal. It is very important to stir well whilst adding the phosphor-tin. Never add more than 12 per cent, however, or trouble will be encountered.

Institute of British Foundrymen.

LANCASHIRE BRANCH (JUNIOR SECTION).

Election of Officers for 1926-7.

At the annual general meeting, held on April 17, the ballot for the offices of President, Vice-President, and members of Council resulted in the following being elected. The retiring President, Mr. R. Stubbs, was succeeded by Mr. Jolley, who is foundry superintendent at Metropolitan-Vickers Trafford Park works, and whose activities among the younger members of the foundry trade are well known. Mr. Tom Makemson, the Secretary of the Senior Section, was elected as Vice-President. The following were chosen as members of the Council:—Messrs. Garside, Poole, Hayward, Walsh, Harrison, Jackson. Mr. Bean, who has acted as Secretary since the inception of the Branch, resigned, and Mr. C. F. Brereton was elected to fill the vacancy.

SHEFFIELD BRANCH.

The annual meeting of this branch was held at the Albany Hotel, Sheffield, on April 16, Engineer Lieut.-Commander L. Jackson presiding. Mr. G. Edginton, of Chesterfield, was elected president for the ensuing year; Mr. Ambrose Firth, senior vice-president, and Mr. John Goodwin, junior vice-president. Mr. R. Village and Mr. W. A. Macdonald were re-elected hon. secretary and treasurer respectively. Mr. V. Delport attended as a representative of the American Foundrymen's Association, and gave the members of the branch a cordial invitation to visit the second International Foundrymen's Congress, to be held in Detroit in September next. He gave an interesting account of various features which the Congress will present. Major A. Rhydderch, of Braintree late of Sheffield, gave a lecture on "Principles of Gating and Feeding Steel Castings, with Examples of Comparative Practices," which was followed by a general discussion.

Mr. K. W. Bridges and Mr. H. H. Benjamin submitted to the Committee on Industry and Trade on behalf of the Trade Exhibition Organisers' Association evidence in support of discontinuance of Government subsidies for exhibition purposes.

Councillor Frank Russell, the managing director of the General Refractories Company, Limited, organised and presided over a meeting to explain to the people of Worksop the influence of the local mining developments on the future of the town. He had with him a number of experts capable of treating of the various aspects of the subject.

Aluminium Foundry Practice.

By George Mortimer.

(*Continued from page* 310.)

Fixing Height of Pouring.

This point has received far closer attention in the States than in this country, and there are at least two methods in fairly extensive use, aiming at ensuring a reasonably equal rate of pouring throughout a contract and so cutting out this much at least of the prevalent personal element. The first is to fix the pouring height by mechanical means, or by resting moulds on girders, etc., at the natural height a moulder will pour from. The second method lies in using a simple oil-sand strainer in the gate, pierced with four or five holes about the size of an ordinary pencil. The primary use of such a strainer is its surprising capacity for holding up dross and air bubbles which would otherwise be injected into the mould. It serves a second useful purpose, however, in regulating the flow of metal into the mould over a great number of similar castings, even though the moulder may tend to vary pouring height and rate from casting to casting. If such variable factors as these are fixed as far as possible in advance, much time is saved in exploring an unnecessarily wide field when troubles occur.

Use of Snap-flasks.

The above paragraphs indicate the main difficulties arising out of the low weight of aluminium; before closing this section we would mention one advantage. Because the metal exerts so little pressure on the mould, a great range of parts can economically be moulded in snap-flasks. This method economises in moulding boxes and labour of handling, and provides almost ideal natural venting.

Aluminium Moulding Boxes.

Moulding boxes are practically always made of aluminium re-melted skimmings and swarf in aluminium foundries; they are light to handle, cheap to machine, practically unbreakable; whilst in emergency they can always be melted down and run into low-grade castings.

Clean Finish.

For a clean white finish, the moulds and cores are dusted over with either French chalk, or a mixture of this with graphite. Lycopodium is also extensively used. Graphite by itself tends to give a dull finish.

Knocking out, and when to do it, is a question for individual experience on particular castings. The contraction and hot-shortness of the light alloys suggest the desirability of releasing cores as soon as possible. The hot-shortness, plus average foundry handling, suggest leaving well alone.

It is so easy to damage castings slightly when they are at a high temperature, that one should modify the accepted rule, that they should be removed from the sand as early as possible. It is suggested that where castings show cracks, however rapidly the cores are released, it might be a good plan to leave them in the mould over-night. It is possible that the cracks might then be conspicuous by their absence.

Dressing.

Dressing, in the case of aluminium, is a matter of peculiar ease. Gates and risers are quickly cut off by a band saw, and if they are so placed that a band saw can cut them close to the casting, there only remain the usual thin flashes, chill marks, and so on, to be dressed by an emery wheel, or by chisel, hammer and file.

Where a particularly well-finished job is required, either sand-blasting or bobbing with a wire brush are recommended. A white matt surface is obtained by dipping in hot caustic soda, neutralising by a dip in weak nitric acid, washing thoroughly and drying. Sand-blasting by itself gives a fine grey matt finish, and if ribs and lettering are then highly polished a very good effect is obtained by the contrast of the silver against the grey. The polishing of numerous small castings is readily accomplished by tumbling with steel balls, at some slight cost of clean definition.

Salvage, Reclamation and Repair.

Many otherwise clean and sound castings are marred by some small blowhole or crack, or locally fail to withstand hydraulic pressure tests without sweating. In most cases such work can be made perfectly good by soldering, welding, doping or caulking.

Soldering.

This is in no case recommended except where the defect does not in any case affect the serviceability of the casting, and where the cavity can be so undercut that the solder will not tend to come out whether there is an actual "joint" between it and the casting or not.

There are now solders on the market for aluminium which can be guaranteed to give a good, strong joint, given attention to directions for use. There is none in which a permanent joint can be guaranteed, under all conditions of service. Most available solders for aluminium part company with the job they are used on in a very short time, hence the need for undercutting. Soldering of aluminium which can be guaranteed to give a good of a dental operation only; a filling for appearance's sake, not an engineering job.

Welding.

All the alloys dealt with may be welded with an oxy-acetylene apparatus in the normal manner, with or without a flux. It is safer to pre-heat the casting before welding, or contraction stresses may be set up and result in serious cracks. Intricate and highly stressed castings are best annealed afterwards for a couple of hours at about 350 to 460 deg. C., and allowed to cool off in air, but this is a needless refinement in the great majority of castings in general routine production.

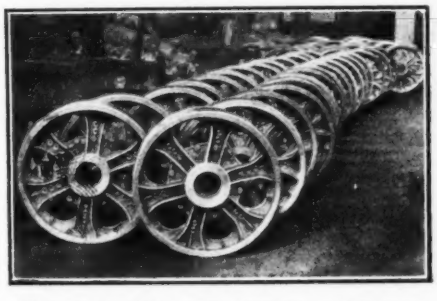


Fig. 13.—London General Omnibus Wheels made from Aluminium Alloy.

A flux is useful for dissolving the inevitable oxide film, the main obstacle to the flowing together of the casting and welding stick. In normal practice, however, a flux is seldom necessary, the film being removed by puddling with the welding stick. The latter should be of the same composition as the casting, and if casting and stick are brought together in the flame so that they are locally at the point of fusion, the oxide film may be scooped off by the stick in the presence of a reducing flame, and a good weld obtained. In some respects welds obtained thus are preferable to those obtained with a flux, for if the latter is used too copiously and left in the weld it can cause trouble later on.

Cracks are often superficial only, and may be deeply grooved along the line of the crack and welded up in a couple of minutes. If they go right through the casting, the latter is best scraped. If a crack right through the casting, however, does not necessarily affect its utility for the job, drill a $\frac{1}{4}$ in. hole at each end, groove deeply on both sides of the casting, and weld up the whole.

D

Blowholes, draws, cracks, insufficient machining allowances and so on, can all be dealt with rapidly on these lines. Welding sticks are available in which no flux is found necessary, and which produce a weld rather stronger than the rest of the casting.

Plugging.

Plugging is resorted to on machined castings, etc., not desirable to risk welding, with its possibility of distortion or contraction stresses. Blowholes are permanently filled by drilling, tapping and plugging. Cracks may also be similarly dealt with; a hole is drilled at one end, tapped and plugged; the centre of the next hole is on the line of the crack at the circumference of the first plug, and so on, progressively to the end of the crack.

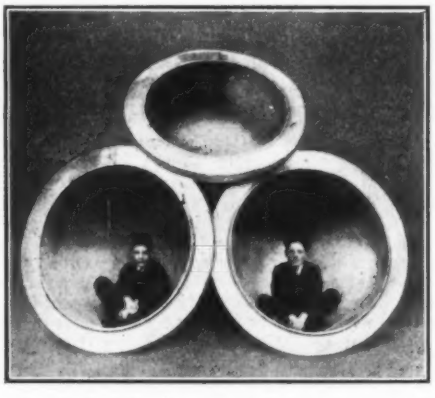


FIG. 14.—LARGE JACKETTED CHEMICAL PANS CAST IN PURE ALUMINIUM.

Such a repair takes less time than would be imagined; it prevents the crack developing further, sets up no stresses in the casting, and is strong as regards internal pressures. It is, in fact, used to a considerable extent in the repairs of cracks in steam boilers.

Caulking and Peening.

A light planishing of surface defects, superficial cracks, draws, local sponginess, sand and chill marks, etc., is readily carried out with a round-nosed hammer or caulking tool. As long as the defects so treated are relatively simple, defects of appearance rather than of strength, this is a rapid and useful method of dealing with them. The extent to which caulking is carried out, however, should be under control; it is possible to introduce incalculable stresses in a casting by "drawing up" cracks or sand holes by heavily spreading the neighbouring metal.

Doping.

Slightly porous castings can be made to withstand hydraulic pressure without leaking by doping with water glass under pressure, preferably hot. The casting is then washed out and dried.

The use of water glass (sodium silicate) is liable to set up slight internal corrosion of the material; it is on this fact, indeed, that its action in closing the pores of a casting depends. Whether such corrosive action matters or not in practice has yet to be decided. In the meantime a very excellent substitute is ordinary linseed oil, introduced under pressure, drained thoroughly out of the casting, and stoved for an hour or two. This dope is as effective as water glass, and has no sort of corrosive action; it tends, in fact, to protect the casting against corrosive action. It tends to slog the ordinary hydraulic testing pumps, and for this reason the cleaner water glass is preferred. If the casting is filled with the oil, however, and air pressure applied, or the ordinary water pump connected up, this objection will largely be met. There is no need actually to pump the oil.

Some industrial waters appear to have much the same effect as water glass, in setting up just sufficient corrosion to close up a porous structure. Where this is the case, testing with tap water and setting aside wet for the night may do as much good as a deliberate doping operation, or as much harm.

If a casting requires doping more than once before it will stand up to the required pressure without leaking, it is advisable to scrap it. Such porosity carries with it poor physical properties, and the necessity for much doping or otherwise is a sound indication of the strength of the casting.

Fusion Welding.

Much subsequent patching and welding is avoided if a close scrutiny is kept on castings as they are knocked out. Whilst the casting is still at a high temperature, slight mis-runs, malformations, sand-holes, cracked ribs, etc., may be made good by so-called "burning on." Sand is rapidly built up around the defect, and a channel for overflowing metal provided. Metal is poured in until partial fusion of the affected area takes place, when the oxide film is puddled off and a sound weld is obtained. Excess metal is quickly scraped off, and finishing left to the dresser.

Fusion welding is much practised in this country, not only in salvage of slightly affected castings, but for major repairs on large crankcases, replacement of broken bosses, and so on. For the process it may be said that the operation is rapid and cheap, that it introduces no factor like dissolved gases in the weld as is the case with oxy-acetylene, and that a weld made thus by an expert is difficult to distinguish from the remainder of the casting on micro-examination. As carried out by a man who understands the problems involved, using the same metal as that in the casting, and keeping a good flow of it over the defect until all traces of oxide are washed away, such welds are entirely reliable. Where they are carried out haphazard, on a nearly cold casting, with too little puddling or too great an economy in the metal poured, they can be a source of weakness which is difficult to trace until the casting breaks on service.

Recovery of Waste Material.

All foundries inevitably produce a certain percentage of by-products or scrap material, and aluminium foundries are no exception. It is the aim of good foundry management, of course, to keep that percentage as low as possible, and also to extract the utmost useful yield from such waste material as is found unavoidable. This material may be roughly classed as under:—

(*a*) *Large Scrap.*—Mis-run or cracked castings, runners and risers, clearance strips, etc., heels from pots.

(*b*) *Spillings and Splashings.*—The inevitable

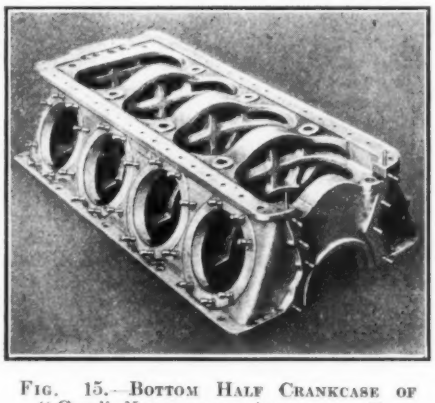


FIG. 15.—BOTTOM HALF CRANKCASE OF "CUB" NAPIER, THE ALUMINIUM CASTINGS OF WHICH ARE BY WILLIAM MILLS, LIMITED.

result of much ladling from melting pots to crucibles, and of carrying the latter through a crowded foundry.

(*c*) *Skimmings.*—The dross and scum removed from the surface of metal just before ladling from pots or pouring from crucibles into the mould.

(*d*) *Sawings.*—The heap of particles which collects beneath the band-saws.

(*e*) *Grindings.*—The fine dust from emery bobs which collects in the dust extractors.

With regard to (*a*) and (*b*), these may be returned to the pots in current use for castings

of the second grade, relatively unstressed work. The only precaution obviously necessary is the separation of any dirt, sprigs, or other foreign material taken up from the floor by spillings. Lack of care in this respect is one of the causes of "hard spots" encountered during machining castings.

Skimmings consist largely of metallic alloy containing much entrained oxide, forming a stiff lace network or spongy mass, and preventing ready fusion of the metallic content. The introduction of about ½ per cent. by weight of zinc chloride liberates the metal, enabling the oxide to rise, if somewhat unwillingly, to the surface as a fine dusty powder.

In large plants skimmings are treated in an iron pot by themselves. As each charge of newly melted alloy reaches its teeming temperature, the skimmings from all pots in turn are deposited in one adjacent melting pot. Here, on attaining the right temperature, flux is added and stirred in, the pot temporarily closed, and the dross allowed to rise for skimming off. Almost the whole of the metallic content is recoverable by this method.

Machine Swarf, Sawings and Other Fines.

These are the *bête noir* of the foundryman, and if not logically treated they may be a continual source of loss. The extent of this loss may not be appreciated in many cases, since it is not very widely known how, with a little thought and trouble, this class of material may be made to yield a high percentage of reclaimed metal.

Some foundries sell all fines to metal merchants, a method of disposal which for simplicity cannot well be improved upon. The market rates obtainable are, however, low, and it is largely on this account that attempts are made to reclaim sawings, etc., which tend to run into large figures on a heavy weekly output.

Any attempt to melt down fines direct in bulk is doomed to failure at the outset from the point of view of economy. A moment's consideration of the conditions will indicate this. Each and every particle in the mass of sawings is coated with a thin but tough skin of oxide. By raising the temperature of the mass sufficiently, the metal within that oxide skin may well be brought to a molten condition. That, however, is a matter of time and of high temperature, because of the essentially low thermal conductivity of such a mass; and both time and temperature are all that are needed to thicken that oxide skin, and to make it increasingly difficult for the extremely light drop of molten alloy to break through it and fuse with the next. At a temperature of 850 deg. C. the finer sawings begin to burn actively, as seen by the brilliant glow which starts in patches here and there. If this action is allowed to continue the whole mass is quickly converted to oxide. Yet in the direct melting of fines it is difficult to get any change in the charge at all unless this temperature is approached.

The addition of large percentages of zinc chloride assists matters, but whatever flux is used the tendency to oxidation in this process is extremely marked. In other words, time, labour and melting charges are largely expended in converting a potentially valuable material into one which can be dug up in any back garden.

For this reason it is more general practice to provide a good heel of already molten alloy in the pots, into which the lower layers of fines are forced by the weight of the charge above. The insidious danger of this method lies in the very fact that it is such an improvement on the first method and that the value of the metal recovered generally exceeds the sum obtainable for the swarf itself. Thus the system appears economical enough: there is a tendency to take what the gods provide and to rest on one's oars.

Yet the total yield against that theoretically possible is invariably low: there are indeed cases on record where the total weight of metal recovered has been no more and no less than that of the original heel with which the long and costly operation was started. It cannot be too strongly emphasised how readily fines are converted to oxide, and how easy it is to reach temperatures at the bottom of the pot which will tend also to oxidise the heel. If this same heel were systematically weighed before each reclaim melt were started, the net effect would often be found disappointingly low after "running down" a large quantity of sawings.

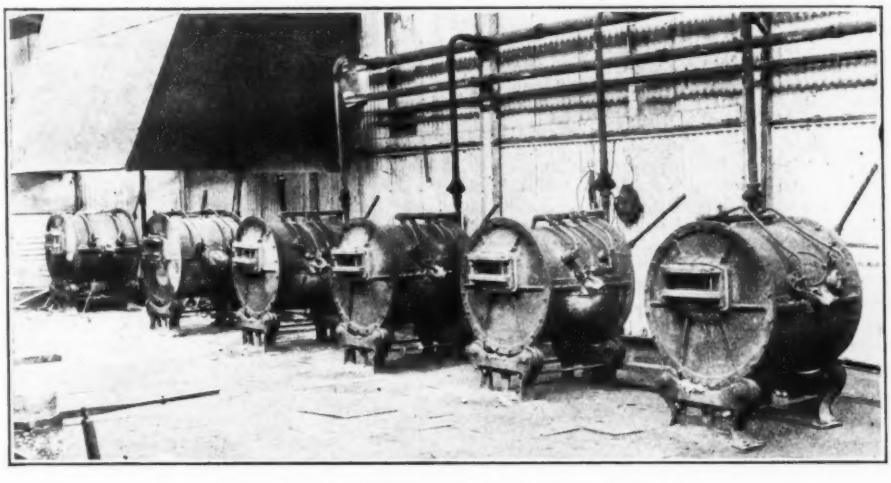


FIG. 16.—A BATTERY OF SELAS TURNER FURNACES.

In foundries having a keen and intelligent executive this factor has received due recognition for some time, and as a result of much patient experimental work in this country and in America, a method of dealing with sawings and similar swarf has been developed which does reclaim a high percentage of the metallic content.

Briefly, that method consists in providing a molten heel as usual, but in adding the fines only in small quantities at a time, and puddling each quantity thoroughly into the heel before adding more.

Now, to rabble these sawings into a molten heel of metal may be compared with pushing cork packing into a bowl of mercury with a pencil: an intriguing proceeding, but very unproductive of useful result. For this reason the heel is kept at round about 670 deg. C., or in a pasty condition. The particles are brought to this pasty condition by intimate contact with the heel, and the oxide skin is broken down by sheer mechanical abrasion. In other words, the particles are welded into the mass, at a temperature at which welding best takes place and rapid oxidation does not.

The sawings are introduced little by little and the mass steadily puddled, until all oil is burnt off, the oxide skin broken down, and the particles join the growing solid mass of the heel. If the latter gets too liquid, drop in a lump of large scrap. When it gets too large for convenient manipulation, allow the temperature to rise until the mass is thoroughly fluid, stir in from ½ to

1 per cent. of zinc chloride and immediately skim. Ladle into chill moulds leaving enough in the heel to recommence operations, drop in a lump of scrap to reduce the heel to a pasty condition, and start again.

A word in regard to those skimmings. If they are stacked in piles intense heat is shortly developed, burning out any zinc content, converting any metallic shots to oxide, and generally reducing the value of the material. When the pot is skimmed, therefore, spread the skimmings out at once on the floor or on iron plates, so as to force it to cool rapidly. When cool, a considerable amount of metal may be riddled out of this material and re-charged for melting. The final dross, riddled free of metallic content of any importance, is a saleable commodity to industrial chemists at a few shillings a ton, which is just better than having to pay either rent for dumping or freight charges for carting away.

The percentage recovery by the above method is remarkably high, but the best results are only obtained if sawings, etc., are kept reasonably clean. The presence of oil and grease are practically unavoidable: they are used as lubricants in sawing. A certain amount of dust is also unavoidable: but if a labourer is allowed to sweep sawings right across a shop to a general heap, he will collect much dirt and foreign matter which is wholly avoidable.

This method needs constant attention, and the criticism which may be urged against it is cost of labour. In actual practice labour costs are little affected as compared with any preceeding method, whilst the yield per cent. in reclaimed ingot amply compensates for any extra trouble or supervision. The need for continual puddling renders it impossible to use a lid on the pot, and although from a technical standpoint this is not serious, because of the low temperature employed, from the human point of view a word should be put in for the operator. It is very desirable in the interests of health to use a well cowled furnace for this process, and to see that chimney capacity and surrounding ventilation are beyond reproach.

Grindings, from emery wheels and buffs collect in the receivers provided, together with much fine abrasive material. The metallic content is in an extremely finely divided state, and is difficult to deal with by any known method suited to foundry routine. This material is best sold to chemical manufacturers for what it will fetch, for recovery or conversion by chemical processes.

SUMMARY.

The foregoing hints on the peculiarities of light alloys, and how they may be dealt with in the foundry, touch only the fringe of the subject. Like the warnings and hieroglyphics that plaster the highways, however, they will seem as complicated to the tyro as they may be almost irritatingly superfluous to the expert. Yet those same road signs are regarded by novice and experienced motorist alike with due respect, and so the world becomes a little safer for democracy. And that is all that is aimed at.

Obviously aluminium castings are produced successfully from one year's end to another by men who never bother their heads about specific gravity, and who have never heard of crystallisation shrinkage. There are castings produced in thousands which are poured down one hole in the cope, and that hole becomes the solitary riser: and they are poured from re-melted Zeppelins or parts of submarines sunk in the early part of the late war, regardless of chemical composition, content of alumina, regardless of anything beyond cheapness of raw material and saleability of the finished article.

It is to the credit of aluminium that such castings do sell, and that they do quite often stand up to their job. It discredits aluminium when one casting fails to stand up to the service it was designed for.

Light casting alloys are at least as reliable as any other engineering material, given attention to the above points: no aluminium casting need ever fail in service, given reasonable design for the job in hand, and careful interpretation of the instructions we have given. The advantages which accrue from the use of reliable aluminium castings are so striking, that a little organisation on the above lines will well repay those who care to take the necessary trouble.

Advantages of Aluminium Castings.

The most obvious advantage is the weight reduction. This means primarily that where one buys enough metal to make a brass casting the same weight will make three aluminium castings. In addition there is lower handling and freight charges and so on. The economical points are now fairly generally recognised. What is not quite so generally recognised is the value of low weight technically, in the case of parts which must be accelerated rapidly and brought to an abrupt standstill. As, for instance, in large quick-break switch parts, in which simple aluminium castings have been known to stand up where high tensile bronze castings failed.

The speed of machining possible with the alloys referred to is notoriously high: an economical factor in an age when time is money.

The finish obtainable on light alloy castings is at least equal to that of brass and incomparably superior to iron. A polished surface on aluminium is as beautiful as one of brass, and it lasts longer. This particularly applies to castings exposed to sulphurous fumes or an atmosphere of burnt gas. Gas fittings, for example, when made in any of the above alloys, neither tarnish nor corrode in the unsightly manner seen in brass fittings.

Finally, all the alloys outlined may readily be die-cast in cheap cast-iron chill moulds, gravity poured by unskilled labour.

The economical value of die-casting need not be unduly stressed here, since it is so widely appreciated. It is so generally recognised that the die-casting of brass has received close and costly attention of late, while in the States at least one firm produces iron castings from permanent moulds.

Neither in brass nor in iron, however, is the operation carried out with the extreme facility seen in aluminium, nor do the dies cost so little or last so long. Where great numbers of small parts to the same design are required, there the utility of an easy die-casting medium is most emphasised. And in this the alloys of aluminium excel.

Wasters are cut to a minimum, machining is largely eliminated or is simplified by ease in jigging, a large output may be steadily maintained from a very small floor space, and the strength of the casting is rather better than from a sand mould. No material, suitable as a substitute for brass in general engineering, offers these economical advantages except aluminium.

Patent Specifications Accepted.

The following list of patent specifications accepted have been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full specification can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

The last numbers given are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken. The following have been placed on sale:—

25,386. Davies, E. W. Rolling mills. Oct. 24, 1924. 246,224.

26,582. Doughty, T. Rolling joists. Nov. 7, 1924. 246,248.

26,705. Coroneo, D. C. Cutting metals and other materials. Nov. 8, 1924. 246,250.

8,413. Crowe, H. Blast-furnace tuyere connections. March 30, 1925. 246,346.

20,695. Gelsenkirchener Bergwerks Akt.-Ges. Centrifugally casting hollow metal bodies. Oct. 22, 1924. 241,862.

5,832. Murray, T. E. Apparatus and methods for moulding conduits. (March 3, 1925). 245,964.

6,925. Smith, W. H. Machines for moulding plastic substances. (October 18, 1924). (Divided application on 232,366). 245,970.

10,823. Askania-Werke Akt.-Ges. Vorm. Centralwerkstatt-Dessau Und C. Bamberg-Friedenau. Gas-fired furnaces. (May 31, 1924). 234,792.

21,498. Karrenberg, G. Crowns or roofs of furnaces (August 27, 1925.) (Addition to 230,691). 246,060.

29,714. Wagenbach, A. Device for bending metal rods. (November 24, 1925). 246,088.

Some Further Notes on Pearlitic Cast Iron.—Part II.

By J. E. Hurst.

The conditions outlined in the Diefenthaler patent British No. 147933 discussed in Part I of these notes require to be further amplified by a consideration of the conditions outlined in a further patent, British No. 210,091. This latter patent gives more complete instructions which are fully embodied in the diagrams Figs. 1 and 2 taken from this document. These diagrams have been extended in certain places in order to intersect the zero co-ordinates, and the three diagrams given in the patent specification have been drawn as one diagram in Fig. 2. The dotted vertical lines in this diagram indicate the extent of the curves as drawn in the patent specification; the extension of the diagrams beyond these limits has been made by the writer.

Referring to Fig. 1, three curves are given joining certain total carbon contents with certain silicon contents on the OY and OX axes respectively. These curves represent three series of alloys, in which the sum of the total carbon and silicon contents are of constant value. The sum

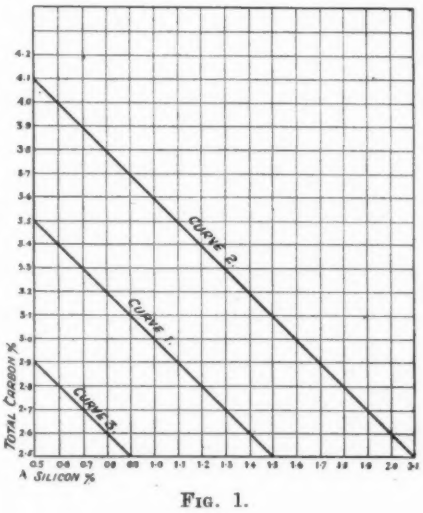


Fig. 1.

of the silicon and total carbon contents of the alloys represented by curves Nos. 1, 2, and 3 are respectively 4.0 per cent., 4.6 per cent., and 3.4 per cent. Corresponding curves, Nos. 1a, 2a and 3a, are drawn in Fig. 2 relating to mould temperatures and mould thicknesses. The procedure is as follows:—For an alloy whose composition lies on curve 1 the temperature of the mould for various thicknesses of casting are obtained by reference to curve 1a, and similarly the other composition curves are referred to the corresponding thickness temperature curve.

A comparison of the curves in Fig. 2 with exactly similar curves constructed from the previous specification, and illustrated in Part I of these notes, reveals certain points of importance. These curves have been added to Fig. 2, for the purposes of comparison. The new curves in Fig. 2 are not parallel, as in the case of the original curves, and the connection between them is not clear. It is difficult to understand how interpolation is to be used for intermediate values of the total carbon plus silicon contents.

The numerical values of the mould temperatures given by the curves in Fig. 2 are vastly different from the original figures. For example, curve A represents an alloy, the sum of whose total carbon and silicon contents is 4.0 per cent. This curve is directly comparable with curve 1a, representing exactly the same alloys. For a casting of 0.5 in. thick the mould temperature originally specified was 180 deg. C. The mould temperature for this same size of casting, according to curve 1a, is 460 deg. C.

It is of extreme importance to notice the fact that in the curves as drawn in the patent specification the curve 3a, representing alloys containing up to a maximum of 0.9 per cent. silicon, is not projected below a casting thickness of 2.5 in. There is here an inference that such low silicon contents are not to be used below this casting thickness. If this is true, what difference is there between pearlitic practice and ordinary practice?

There are two further points of general importance on which these curves are open to criticism. The first is the practice of adding together the total carbon and silicon contents. There is no justification for this procedure, and why the important influence of manganese and sulphur is omitted from the curves the writer is at a loss to understand. Secondly, the curves as drawn show that a certain set of cooling conditions in a casting of given thickness produce identically the same structural results indepen-

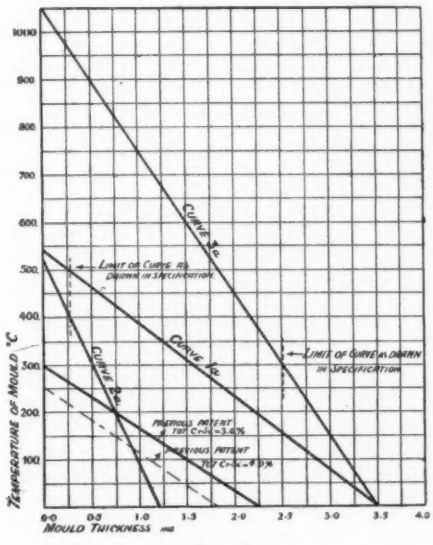


Fig. 2.

dently of the composition. For example, a casting of an average thickness of 1.5 in. in a mould at a temperature of 300 deg. C. (Curve 1(a)) will presumably cool at a certain mean rate, independently of the composition of the metal. Now, according to Curve 1, this casting may be made of cast iron varying in composition from 3.5 per cent. total carbon and 0.5 per cent. silicon to 2.5 per cent. total carbon and 1.5 per cent. silicon. According to the Perlit process, all these varying compositions will be accompanied by the same result (*i.e.*, the pearlitic structure) when cast under these conditions. The obvious absurdity of this is clearly shown when we consider the following facts deduced from the curves:—Cast irons containing total carbon 3.5 per cent., silicon 0.5 per cent. (Curve 1), total carbon 4.1 per cent., silicon 0.5 per cent. (Curve 2), total carbon 2.9 per cent., silicon 0.5 per cent. (Curve 3), are presumed to solidify as grey pearlitic irons when cast into moulds at a temperature of 0 deg. C. (not heated in any way), at casting thicknesses of 3.5 in. and 1.2 in. respectively. Common observation shows this to be absurd. For example, the following analysis is a typical example of a well-known British pig-iron, produced by casting in ordinary sand moulds at the pig bed. Such pig-irons can be regarded as of approximately 3.5 in. square section, and normally have a white fracture. According to Curve 1a, however, this pig-iron would be expected to solidify grey and machinable with a pearlitic structure.

Chemical composition of a white iron:—CC 3.50, Gr Nil, Tot. C 3.50 (equivalent to requirements of

curve (1)), Si 0.50, Mn 0.20, S 0.14, and P 0.036 per cent.

The Influence of Mould Temperature.

To understand this aspect of the subject it is necessary to consider the manner in which the cooling of a casting takes place. It is well known that an iron of a given chemical composition solidifies either white or grey according to whether the rate of cooling is faster or slower than some critical value. In considering the rate of cooling it is necessary to consider it both from the point of view of its relation to the position in the mass of the cooling body and to the temperature at which graphite commences to form.

The rate of cooling is not a constant rate throughout the whole mass of a cooling body nor is it a constant rate during the cooling down of a mass of metal at all temperatures. The rate of cooling is usually measured as the rate of fall in temperature or, in other words, the fall in temperature which occurs in unit time. Broadly speaking the rate of fall in temperature or the rate of cooling becomes slower the more nearly the centre of the mass is approached, and also becomes slower as the temperature of the metal falls off. Whilst this is well known to foundrymen it is not as clearly understood as it might be.

By carefully simplifying the conditions one can use some of the simpler analytical methods used in the mathematical treatment of heat conduction.

In order to enable us to discuss the rate of cooling as a function of the time and of the depth in the metal, let us imagine a large mass of cast iron at a temperature of θ_1 instantaneously cooled at its surface to a temperature θ_2. If we neglect the change in the value of the thermal constants with varying temperatures and also all latent heat considerations, we are able to compare the rates of cooling $\frac{\delta\theta}{\delta t}$ at different times (t) and depths (x) within the mass by the use of the equation:—

$$\frac{\delta\theta}{\delta t} = \frac{-\theta_0 x}{2h\sqrt{\pi}\, t^{\frac{3}{2}}} \cdot e^{\frac{-x^2}{4h^2 t}}$$

where $\theta_0 = \theta_1 - \theta_2$ and h^2 = diffusivity.

This equation is derived from the fundamental Fourier equation of conduction, and the curves in Fig. 3 showing the rates of cooling at depths of 3 mms. and 10 mms. within the mass as a function of the time have been computed from it.

Under the same conditions the time-temperature curves can be plotted by use of the equation:

$$\theta = \frac{2\theta_0}{\sqrt{\pi}} \int_0^{\frac{x}{2h\sqrt{t}}} e^{-\beta^2} \cdot d\beta$$

If the time-temperature curves are plotted for different depths within the mass of metal on the same diagram as the rates of cooling, to the same time scale, we are able to compare the rates of cooling at different depths within the metal at the different temperatures when cooling takes place under the conditions prescribed above.

This has been done in the diagram Fig. 3. The A and B are the calculated time-temperature curves for depths of 3 mms and 10 mms respectively for an imaginary mass of metal poured into a mould at θ_2 deg. C., and instantaneously brought to this temperature at its surface.

At a depth of 3 mms. the rapid increase in the value of the rate of cooling up to a maximum, and its gradual falling off as the temperature falls is clearly shown by comparing curves R(3) and A.

Similarly by comparing curves R(10) and B the same point is demonstrated.

By comparing the curves R(3) and R(10) the falling off in the value of the rate of cooling as the depth within the metal is increased, is illustrated, and also the slowing up in the rate of fall of temperature by a comparison of curves A and B.

If instead of being poured into a mould at 0 deg. C. the metal is poured into a mould at 450 deg. C. and instantaneously brought to this temperature at its surface, the form of the rate of cooling curves remains identical, and all that alters is the quantitative value of the rate of cooling. This is, and is given as, a function of the temperature difference θ_0 ($\theta_1 - \theta_2$) which in the former case is (θ_1 – 0 deg. C.) and in the latter case is (θ_1 – 450 deg. C.). The time temperature curves are therefore altered, and they have been plotted for these conditions as curves C and D in Fig. 3. These clearly show that the fall in temperature is slower under these conditions, but at the same time a similar degree of difference exists between the rate of fall in temperature at different depths (3 mms. and 10 mms.) within the metal as in the case of the cold mould.

In other words the curves show that whilst the actual values of the rate of cooling are decreased as a result of increasing the mould temperature the difference in rate of cooling as the depth within the mass of metal increases still remains.

A further point of vast importance is disclosed by these curves. It will be seen from the rate of cooling curves that a pronounced maximum rate of cooling is attained at a certain point of time. This maximum naturally occurs at a later time with increased depth within the mass of metal. By a comparison of these curves with their respective time-temperature curves it is also shown that this point of maximum rate of cooling occurs at a certain temperature. For example, the maximum rate of cooling of ($1.3 \times \theta_0$) deg. C. at a depth of 3 mms. occurs at a temperature 1,080 deg. C., and at a depth of 10 mms. the maximum rate of cooling of ($0.12 \times \theta_0$) deg. C. occurs at a temperature of 1,040 deg. C. in the examples plotted in the curves. The effect of increasing the mould temperature alters in a

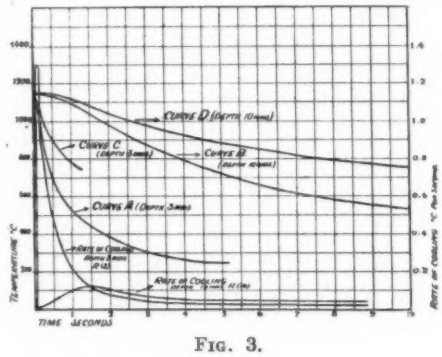


FIG. 3.

measure the relation between this maximum and the temperature. In the example given in the curves the maximum rate of cooling at a depth of 3 mms. occurs at a temperature of 1,100 deg. C. when the mould temperature is 450 deg. C. and at a depth of 10 mms. the maximum occurs at a temperature of 1,080 deg. C. under similar conditions. The importance of this influence lies in its connection with the critical ranges. The critical ranges at which constitutional changes take place on cooling occur at either constant temperatures or constant ranges of temperatures. It will be seen that the rate of cooling of the metal at a given critical temperature may be modified by variation in the mould temperature. We may summarise the effect of increasing the mould temperature under the general conditions of cooling as outlined above and embodied in the curves Fig. 3 as follows:—

(*a*) Increasing the mould temperature and maintaining other conditions as stated lowers the value of the rate of cooling throughout the mass of cooling metal and at all times and temperatures during the cooling down; (*b*) the fall in temperature takes place more slowly in cases of increased mould temperature; (*c*) the rate of variation of the rate of cooling from the outside edges inwards towards the centre of the mass is unaffected by the increase in mould temperature; (*d*) the coincidence of the points of maximum rate of cooling with particular critical temperatures or temperature ranges is altered by increasing the mould temperature.

The case of cast iron cast in sand moulds is actually different from the case of cooling considered above. The mathematically instantaneous cooling of the outside surfaces to predetermined temperatures, which has been presumed in the case above is not obtained in practice. The cooling is generally very much slower than under the

conditions above. The effect of this can be imagined by considering the curve for 10 mms. depth (Fig. 3) to be actually the curve for a depth of 3 mms. under sand-casting conditions. This might conceivably represent the cooling under sand casting conditions which will obviously alter very considerably the numerical value of the rate of cooling. Whilst the numerical values are altered the effect of increasing the mould temperature in sand moulds will be accompanied by the same effects as summarised in (*a*) (*b*) (*c*) and (*d*).

It may therefore be concluded that the effect of increasing the mould temperature of sand moulds on the cooling of the metal is—(1) To slow up the rate of cooling at all times, temperatures and points within the mass; (2) has no effect on the difference in rate of cooling from the outside edges to the centre of the mass; and (3) alters the coincidence of the points of maximum rate of cooling with the critical temperatures.

The Influence of Mould Temperature on the Structure of Cast Iron.

We are now able to examine the effect of the influence of the increased mould temperature on the structure of the iron, with particular reference to the claims of the Perlit process.

In the first place the effect of the increased mould temperature is to retard the rate of cooling in every respect. The slowing of the rate of cooling during the crystallisation period will have the effect of increasing the grain size in the final solid metal. As a direct result we may expect to find Perlit iron made in hot moulds to have a larger grain size—a larger graphite size than the same iron produced in cold moulds.

The grain size is absolutely independent of the structure and the constituents present, and since the variation in the rate of cooling from the outside edge to the centre is unaffected by the increased mould temperature, we may expect to find that the grain size varies from the outside edge to the centre in hot mould iron in exactly the same manner as it does in cold mould iron.

In spite of this the pearlitic structure may exist uniformly across the section. The effect of rate of cooling on the pearlitic structure within very wide limits is governed entirely by the extent of the graphitisation which takes place before the pearlitic change point is reached. This in its turn depends upon the rate of cooling in the early stages of solidification. If the chemical composition is so adjusted that under the conditions of cooling graphitisation takes place in the early stages to such an extent as to leave the saturated solid solution, then at the pearlite change point pearlite will be formed in spite of variations in rate of cooling within very wide limits.

Since exactly the same variation in the rate of cooling across the section exists whether the mould is heated or not, we may at once conclude that if a uniform pearlitic structure can be obtained across the section of a mass cast in a hot mould then an exactly similar result can be obtained from a cold mould. All that is necessary is a suitable modification in the composition. This is borne out from an examination of the Perlit proposals.

The effect of using a hot mould on the structure of the iron may therefore be summarised as resulting principally in a larger crystal grain structure across the section of a mass of cast iron than would be obtained from the same material cast in a cold mould. Whilst a uniform pearlitic structure might be maintained across the section of a mass of cast iron, a variation in the grain size must exist, since the variation in rate of cooling persists in spite of the heated mould. The exact influence of the grain size on the strength properties is not known, but we may at once conclude that the larger crystal grains of the hot mould iron will not be accompanied by higher strength values or higher impact values. Also that there will exist a difference in the mechanical properties such as the tensile strength and impact values across the section of a mass of cast iron in spite of the uniform pearlitic structure.

Relation between Mould Temperature and Composition.

In the above consideration of the influence of mould temperature on the structure it is tacitly understood that the comparisons drawn are purely between mould temperatures, and it is assumed that the chemical composition remains constant. In actual fact it is probably true that when a hot mould is used the composition of the iron used is different from what would be used in the case of a cold mould iron. The difference always tends in the direction of lower silicon, for the slower rates of cooling in the hot mould iron allow of this without the same degree of risk of local chilling at the surfaces of the casting. Also, in view of the slower cooling, it is necessary to use a lower silicon iron in the hot mould iron to maintain the feature of uniform pearlite across the section. This fact should never be lost sight of; it is not the hot mould that is responsible for uniform pearlite, but the chemical composition.

There can be no doubt that owing to the slower rates of cooling, cast iron of lower silicon content than normally used in cold moulds can be cast in hot moulds, and it is very probable that owing to this lower silicon content the falling off in strength and impact values as compared with cold mould iron due to the increased grain size will be somewhat counteracted.

Whether there is any real point in attempting to reduce the silicon contents of irons below those normally used is uncertain. If there is no real point in doing this, there is no real point in using hot moulds. From the point of view of mechanical tests it should not be forgotten that, providing low-phosphorus irons are used, the low total carbon contents postulated in some of the Perlit curves will have far more influence than the increased mould temperatures in the production of iron of high strength properties.

Summary.

(1) The attempt to relate chemical composition, thickness of casting and mould temperatures by a series of straight-line curves, as outlined in the patent specifications of the Perlit Process, results in serious anomalies and absurdities.

(2) A consideration of the features governing the rate of cooling shows that whilst the effect of increasing the mould temperature has the effect of slowing up the rate of cooling it does not affect the rate of variation of the rate of cooling across the section of a mass of metal.

(3) The principal effect of this is to produce a larger grain size in the resulting casting, and it serves to show that whilst uniformity of the pearlitic structure throughout the whole thickness of a casting may be obtained, a similar degree of variation in the properties from the outside to the centre of the thickness may be expected in hot mould irons as in cold mould irons.

(4) As a direct result of the larger grain size it would be expected that the properties would be inferior to those of the same material cast in a cold mould. It is highly probable that the explanation of any improved properties observed in perlit iron are to be ascribed more to the modified composition than to the use of a hot mould.

(5) Except for the fact that a somewhat lower silicon iron than normally used can be cast in a hot mould, it is unlikely that the hot mould confers any structure or distribution of structure throughout the mass of a casting which cannot be duplicated in a cold mould.

These conclusions are merely deductions from a consideration of this subject on the basis of the information which is generally available. The correctness or otherwise of these deductions still remains a matter of actual experiment. It is not a difficult matter to demonstrate by actual tests and experiment the influence of a hot mould and the correctness of the above conclusions. Authoritative tests with this end in view have not yet been made available, and there are yet no tangible demonstrations published to refer to, to enable those interested to determine whether there is any advantage to be gained in using a hot mould, and whether the results obtained are likely to be equal to or be superior to the results obtained by following the ordinary practice.

Machine Plate Moulding Practice.

After the annual general meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, held in the College of Technology, Manchester, on April 17, Mr. J. Dean read a Paper entitled "Some Notes on Machine and Plate Moulding Practice."

The object of plate moulding was to cheapen and increase output with an accompanying greater uniformity and higher quality of work. The perfect machine was that which would fill the boxes, ram the sand, withdraw the pattern, and in the ideal case, close the mould. The various types of machines were explained and their advantages enumerated. The jar-ram machine was considered the best, as the ramming was more effective in that type than in the ordinary squeezing machines. The limitations of machines were discussed, and these limitations lay in the fact that much work had still to be done by hand. Also, many patterns were so complex that it became too costly to deal with these on the machine; the cost of the necessary devices outweighed the gains in other directions.

The advisability of planing the edges of the boxes that touched when the mould is closed was emphasised. Fine limits of clearance in connection with box-pins were essential for accuracy in production. The clearance of 0.005 in. was allowed on a ¾-in. pin, and 0.015 in. for 1¼ in.

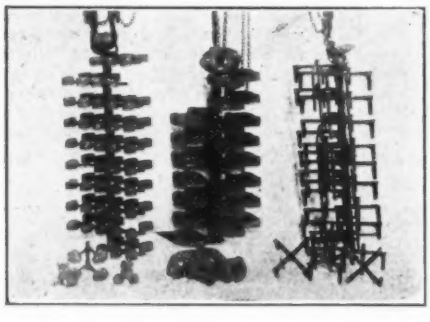


Fig. 1.—An Example of Multiple Moulding, showing Three Stacks of Castings—Cams, Flanges and Air Box Grids.

These were the two sizes of pin which had proved best for plates and boxes. Brass bushes or thimbles were used for the pin holes. The thimbles were run in with white metal, whilst the box part was on the jig plate, which contained the fixed pins.

Standard boxes, 17½ in. long by 12½ in. wide, were used; the depth varied from 4½ in. to 9 in. These boxes had no bars in the tops or bottoms. Perforated plates, so arranged that whilst only the halves of one pattern appear on the plate, and on one side only; yet two moulds taken from the one side of the plate will go together and so produce two complete castings. Such cast-iron plates are arranged with ⅜-in. holes placed 2 in. apart in parallel lines. The plates were of cast iron.

The application of "elastic" boxes and the double pattern plate was described. Where orders are sufficiently large, two machines could be utilised, one to make the top parts and the other to make the bottoms. Type metal containing 80 per cent. lead, 15 per cent. antimony, and 5 per cent. tin, was very useful in making these patterns. Where the order was not large enough to warrant the use of metal plates, then plaster of Paris was extremely useful. Experience was essential with the plaster method. Care should be exercised in the storing of the raw material.

The lecturer showed how close co-operation between the pattern shop and the foundry could effect savings in the cost of production. Important advantages were to be obtained by the use of multiple moulding. In this type of moulding the pattern was usually of the flat-back variety. Boxes were machined on both edges to ensure accuracy in stacking. For this class of moulding the compressed-air machine was recommended. Deep boxes involved extra trouble in stacking and pouring. The method of arranging the pattern plates was a matter of extreme importance, as the two sides of the mould were pressed at once; and only shallow patterns with a regular parting had so far been made by this system.

Fig. 1 shows a stack of cam castings on the left; in the centre are flanges; and on the extreme left are shown a nest of core irons. Sand used for this class of work contained 1 part of coal dust to 30 of sand, and was worked on the dry side. In cold weather gas jets placed under the pattern plate gave perfect draws; the only trouble likely to be experienced then was the trouble of "steamed" moulds. The portable combination "shockless" jarring roll-over and pattern-drawing machine (shown in Fig. 2) represented the most up-to-date labour-saving machine. Except for filling with the sand, the machine was almost entirely mechanically operated by compressed air. The vibrator of the machine gave 30,000 impulses per minute, and this not only assisted in drawing the pattern, but also ensured strict uniformity in the size of castings produced.

Loose pieces on the side of patterns were a difficult problem to overcome. After jarring the sand under these loose pieces was often quite soft. To overcome this, wooden blocks were placed next the loose pieces, the boxes were jar-rammed in the usual way, then the removal of the block exposed the loose piece, which was then rammed by hand. All large or small jobs rammed on the jarring machines were so treated, the result being that

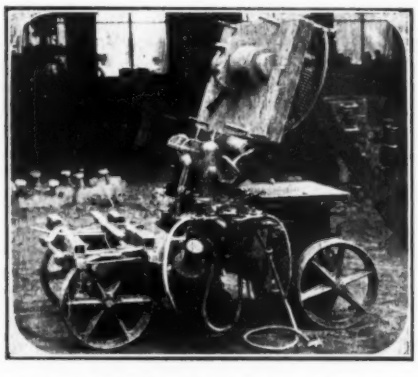


Fig. 2.—A Portable Combination Shockless Jarring Roll-over and Pattern Drawing Moulding Machine.

unsightly joint marks from core prints were eliminated.

It had been found that where many castings required feeding, the problem was to get sufficient risers to do this successfully. Castings weighing from 12 to 56 lbs. were very successfully run from a round block, the thickness of the runner being ⅛ in. over the mould. The down runner was made larger than the in-runner and dropped on to the top of the block. With this method no risers were necessary; the only precaution necessary was that hot metal should be used.

The use of spring clamps to replace weights was cited as saving the machine moulder a considerable amount of time, and they were practically fool-proof. The lecture was fully illustrated by lantern slides.

DISCUSSION.

Mr. Smith asked if in the stacked moulds there would not be a tendency for the bottom box or two to be swollen.

Mr. Jolley (the Chairman) said that the lecturer had styled the machine moulder as a semi-skilled man; that was not altogether true. In the near future big strides would be made in this country with moulding machines; it was the machine of the future, and for that reason was worth all the skill that we could put into it.

In reply, Mr. Dean said that he considered that it paid to take the raw recruit where machine moulding was concerned; such a man would implicitly obey instructions; the moulder was apt to introduce the personal element, which could be so often fatal to good work. Sometimes the bottom boxes would swell, but that was easily remedied by suitable ramming.

It was announced that the examination for the John Wilkinson medal would be held on May 1.

Moulding a Still in Loam.

By J. E. P.

When making a still casting in loam failure may very easily result if some small detail in moulding be omitted. Therefore it is a wise precaution to study the whole job and visualise all the operations involved before starting. In other words, it is not always the fast worker who turns out the best work, and not always in the shortest time, a really good moulder will go about his work with absolute confidence. Should there be no tackle in the foundry suitable for such a job the loam moulder will commence by making the foundation plate, binding rings, stay bars, dome plate packing pieces, and top plate. For large work it is wise to err on the strong side in the matter of tackle. Weak tackle is a continuous source of trouble and risk, often requiring a fair amount of auxiliary tackle to ensure ordinary safety. It is strongly recommended to make all the tackle before starting on the job proper, clean it and stack it near where the job is to be moulded.

Rigging up the Job.

The foundation plate A, Fig. 1, was levelled upon the loam floor central with the spindle pivot B, Fig. 1, upon which the spindle C, Fig. 1, was placed and fixed at the top by the hinged arm D, Fig. 1. The loam board or strickle E, Fig. 1, was then attached to the W.I. arms, F, Fig. 1. The spindle was plumbed, the top hinged arm was made fast by two tie rods from the wall, and the strickle board carefully checked for correct dimensions. The detachable finger-piece G, Fig. 1, is for stricking the seating for the six brackets on the outside of the still.

Having carefully set all this tackle, the brickwork was now commenced. A good supply of soft building bricks was obtained and stacked near to the job. It is important that all bricks for loam work should be thoroughly dry, and if they are not when delivered they should be dried in the mould stove.

The first course of bricks was placed upon a bed of bricking loam laid over the foundation plate. Other courses were built up in a similar manner, spaces being left between the bricks for ashes to allow the gas free exit. All the brickwork was crossed and tied, so as to make a firm building.

The branch pipe pattern H, Fig. 1, was set up to the rake of the strickle board E, and space was left behind the flange so that the pipe pattern was easily withdrawn later.

When the brickwork reached the top of the branch pipe, the first binding ring I, Fig. 1, was put on and hammered down firmly. This ring had slot holes cast in to allow the stay bars to be placed all round the mould at short intervals, also provision was made to allow the flange of the pipe pattern to clear itself in drawing out, also to allow the loam cake at the back of the flange to be put in and securely packed. Spaces were also left in this, as in all other rings, to allow the casting being readily taken out of the mould without obstructions.

The bricking-up went forward again until the position for the brackets was reached, then the seating for these brackets was struck by the fingerpiece C, Fig. 1, which was then taken off and the seating stiffened by placing hot bricks upon it. The wood patterns for the brackets were set in their correct position, and the bricking continued up to the second binding ring J, Fig. 1, when this was fixed and bolted down. The brickwork was continued up to the joint K, Fig. 1, all the stay bars were then placed in and loamed up.

Next, a rough coat of loam was put on the bricks at the face of the mould and allowed to stiffen. Then the face of the mould was struck as clean as possible by using loam of a little thinner constituency, sprinkling water on now and again to give a smooth surface to the mould. When this was accomplished satisfactorily the arm D, Fig. 1, was removed, and the spindle G, with the strickle board E was lifted out of the mould. All the bolts from the top ring J to the foundation plate A, Fig. 1, having been duly attended to, the mould was lifted on to the carriage for stoving.

The part shown in Fig. 2 next received attention. Any plate which could be picked up in the foundry was quite suitable for striking the dummy seating joint A, Fig. 2, which was struck by a straight-edge loam board. This dummy seating was struck in new sand, and covered with parting sand, and on this about ½ in. of loam containing manure was spread, the underside of the lifting ring B, Fig. 2, was covered with clay wash, placed upon the loam and hammered down. The bricking was then started and continued in the same manner as in Fig. 1. The bolts C, Fig. 2, were hooked into the staples of the lifting ring B and built up in the brickwork. The outer ring D, Fig. 2, which fortunately was present, was placed upon the ring B and the bricks built up to it. The top ring E, Fig. 2, was then put on and hammered down, the nuts put on the hook bolts and fastened securely, and then a few more bricks and loam up to the top joint F, Fig. 2. The face of the mould was finished off as in Fig. 1, the spindle G and the strickle board H, Fig. 2, were lifted out of the mould, which was then ready for stoving.

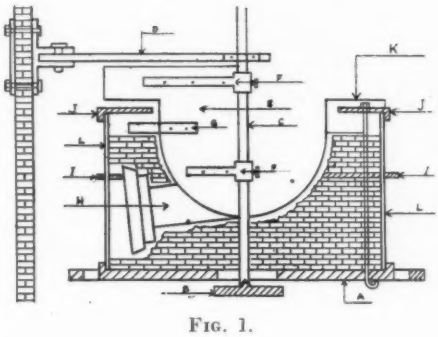


Fig. 1.

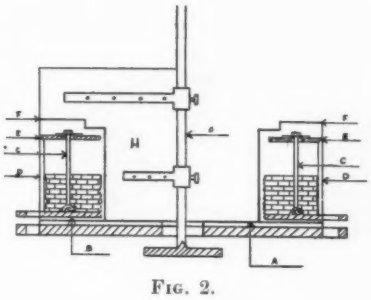


Fig. 2.

Making the Core.

Now the centre part, Fig. 3, was started by placing the top plate A on the floor and levelling and centring in the same manner as the foundation plate.

The top arm B, Fig. 3, was brought round into position and the spindle C adjusted. The strickle board D, Fig. 3, was fixed to the arm E to guard against the spring of the stricking board D, which was over 10 ft. long; a ring F, Fig. 3, was made in open sand, the rounded part was rough-machined, and it was then fixed in the floor central with the pivot centre G, Fig. 3. Both were permanent fixtures on a bed of concrete and grouted in with liquid cement. The small attachment H, Fig. 3, was secured to the main strickle board with battens. At the bottom of this

attachment a small iron roller was fitted and worked upon the race of the ring F, so keeping the main board firmly in its correct position. This arrangement may seem to be a rather expensive method, and the writer is prepared to admit that it would be so in a foundry where little of such work is undertaken, but in a large foundry constantly doing this class of loam work it is a very profitable and reliable method. When this ring and pivot centre is once fixed in the floor the arrangement will last for years, and can be used for many things by the adjustment of the small board H, Fig. 3.

The building of this part of the mould was achieved much in the same manner as the other parts, with the addition of a vertical course of loam bricks. These loam bricks were made by a boy with the aid of a cast-iron frame core-box about the size of a brick. The use of loam bricks in this case, as in many other cases, is to permit the whole brick structure to squeeze in when the solid contraction of the casting takes place. The use of loam bricks in loam moulding has saved many a casting from cracking under the strain of solid contraction.

The centre of the core was left open from the dome plate I, Fig. 3, to the top plate A. This gave plenty of space for the gas to escape.

The bolts J, Fig. 3, were built up in the brickwork, just long enough to pass through the dome plate I, and were bolted down. A space was left in the brickwork at K, Fig. 3, so that the bolts could be securely bolted when the brickwork had stiffened sufficiently. These spaces were made good after the part was dry. Special attention was paid to the brickwork between the dabbers of the dome plate as these dabbers had to carry all the brickwork and loam from the dome plate onward.

Having finished this part, the arm B was swung back to the wall and the spindle C, Fig. 3, with the strickle board D, were lifted out of the mould together. This part was then put into the stove to dry.

When the various parts were dry they were finished off by filing and a good coat of blacking was applied. All the holes left by the spindles were stopped up and made secure, and were stoved again to dry the blacking.

Assembling the Mould.

All parts were finally examined as soon as they were brought out of the stove. The bottom part of the mould, Fig. 1, was then lowered into a permanent casting pit and the top part, Fig 2, placed upon it and adjusted. The bottom edge of the face of the mould, Fig. 3, had been filed off to give the setback its finish.

The top part, Fig. 3, had to be turned over. It will readily be realised that this operation was not a simple one as there were only the lugs on the top plate to lift and turn over by. However, it was successfully accomplished by digging a hole in the sand floor and then placing a large bank of soft loose sand so that when the plate was lifted by two lugs the opposite part of the plate sank into the hole and the cod or core gradually took a bearing upon the soft sand. Then the whole was carefully turned over and picked up by four lugs of the plate, ready to be put into its position on the bottom part of the mould.

Fig. 4 shows the parts assembled. The loam cake A, at the back of the flange of the branch pipe, was backed up with an iron plate B, and securely packed to the stay bars. The core C was held in position by a specially made triple chaplet.

Runners D were placed all round the flange at the top, except one place left for the riser.

About one hour after pouring this mould, the bolts were loosened and the top plate removed and a channel cut in the brickwork down to the dome plate, also a row of bricks cut away from under the flange to allow for contraction. No scrap was used and all the pig was twice melted.

The composition of the pig-iron used was:—Combined carbon, 0.75; graphite, 2.80; silicon, 1.20; sulphur, 0.10; phosphorus, 0.50; and manganese, 0.95 per cent.

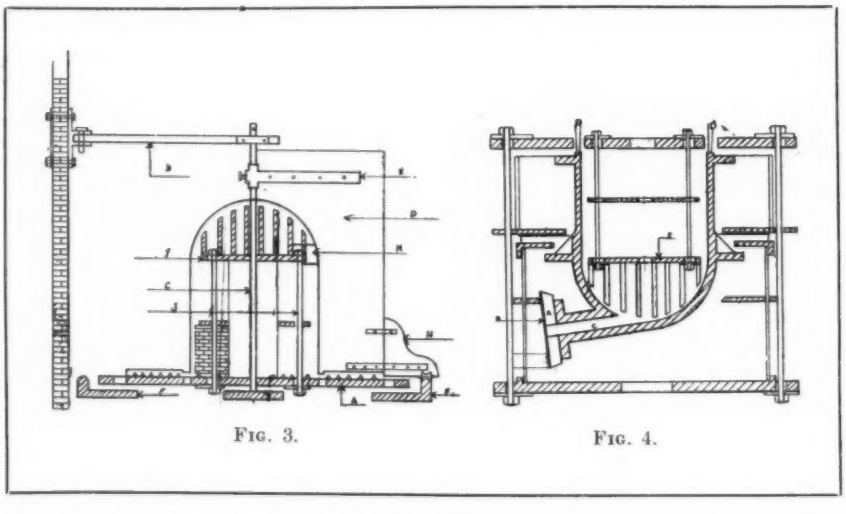


Fig. 3.

Fig. 4.

New Companies.

H. W. Dennis & Company, Limited.—Capital £5,000 in £1 shares. Ironfounders.

Cowan Hulbert Limited, 423, Abbey House, Westminster, S.W.—Capital £20,000 in £1 shares. General engineers.

Harris Brothers (Brierley Hill), Limited.—Capital £10,000 in £1 shares. Iron merchants. 185, High Street, Brierley Hill.

John Hall & Sons (Blackburn), Limited.—Capital £3,500. Spring makers, brass moulders, mill furnishers and engineers. Directors: E. Hall, W. F. C. Schaefer and W. Hope.

Garfitts, Limited.—Capital £10,000 in £1 shares. Agricultural machine manufacturers. Directors: G. A. Garfitt and Mrs. M. W. Garfitt. Registered office: London Road, Sheffield.

A. G. Hatch & Company, Limited, 3 and 4, Bury Court, St. Mary Axe, E.C., steel drum manufacturers.—Capital £10,000 in £1 shares (6,000 7½ per cent. cumulative preference, 2,800 ordinary and 1,200 deferred).

African Smelting & Refining.—Capital £150 in £1 shares. Smelters and refiners of ore and metals. Subscribers: E. Davis, H. W. C. Driver, H. T. Adams, E. Price, J. A. Dunn, E. G. Bunker, J. W. Corble. Registered office: 19, St. Swithin's Lane, E.C.4.

Charles Dickens & Sons, Limited.—Capital £2,000 in £1 shares. Iron manufacturers. Directors: C. T. Dickens, Attwood Street, Lye; D. H. Dickens, 66, Park Street, Wollescote, Stourbridge; and J. E. Dickens, Attwood Street, Lye.

Recess Screws (1926), Limited.—Capital £100,000 in £1 shares (25,500 6½ per cent. cumulative preference and 75,000 ordinary). To acquire the lease, goodwill, patent, etc., of Recess Screws, Limited, and certain plant, machinery and effects of the Kent Construction and Engineering Company.

Fireclay Bricks.

By Edmund R. Thews, M.Sc. Berlin.

Of the refractories used in the metallurgical industries the fireclay bricks have assumed the leading position, since they are not only extraordinarily resistant against the chemical and physical influences of the metals, slags, gases, and oxides, but very stable under sharp and abrupt changes of temperature, as well as against mechanical stresses of all kinds. While, on the other hand, the melting temperatures of the fireclay bricks and their softening temperatures under load are not particularly high, these comparative disadvantages may, by intelligent construction of furnaces, be partly eliminated, so that fireclay bricks have successfully been used for electric steel furnaces even, the working temperatures of which exceed by a few hundred degrees the melting point of the bricks.

Refractory bricks employed for the construction and lining of metallurgical furnaces should possess the following properties in the highest possible degree:—(1) High melting and softening temperatures under load; (2) high resistance against sharp and sudden changes of temperature; (3) low conductivity of heat; (4) high resistance against mechanical stresses of all kinds in the hot or cold condition; (5) high resistance against erosion; (6) chemical inertness against the influence of the fused metals and alloys, as well as against oxides, metallic slags, vapours, and the firing gases; (7) least possible change in shape and volume under practical melting conditions; and (8) uniform composition and methods of production of refractories of similar quality and designation.

Although each one of these requirements represents an absolute necessity, no refractory material has as yet been found possessing all these qualities combined. The fireclay bricks alone of all the common refractories will satisfactorily answer most of the requirements enumerated. The melting and softening temperatures of a refractory brick are dependent upon (*a*) the corresponding properties of its main constituents and the impurities; (*b*) the properties of the binding materials; (*c*) the degree of load applied under practical working conditions; and (*d*) the foreign substances introduced into the bricks throughout melting operations, as metals, slags, gases, etc.

The melting points of the unused fireclay bricks range from 1,480 to 1,730 deg. C. The corresponding figures of other refractories are:—Silica, 1,710 to 1,720 deg. C.; magnesia, 1,542 to 1,710 deg. C.; and bauxite, 1,480 to 1,595 deg. C.

The melting and softening temperatures of fireclay bricks rise with increasing percentages of clay. An addition of 0.50 per cent. of iron oxide above the usual iron oxide contents of the material lowers the softening temperature about 55 to 78 deg. C. Increasing amounts of lime will also lower the softening temperatures, additions of but 0.10 per cent. lowering them as much as 40 deg. C. Increasing amounts of silica cause a corresponding decrease of the melting points. Fine-grained fireclay bricks soften and melt at higher temperatures than coarsely-grained material.

The above figures given for the melting points of different refractory materials are of but theoretical value to the practical metallurgist. Of much greater importance are the softening and melting temperatures of the bricks under load. The following table gives the corresponding figures of the most common refractory materials under a load of 2,500 lbs. per sq. in.:—Fireclay bricks, 1,340 to 1,480 deg. C.; silica bricks, 1,620 to 1,675 deg. C.; magnesite bricks, 1,425 to 1,565 deg. C.; and bauxite bricks, 1,345 to 1,480 deg. C.

Prevention of Loading Refractories Essential.

Wherever the working temperatures of a furnace approach the softening points of the fireclay bricks all efforts should be made to relieve the lining of all unnecessary load. The roof should, for this reason, never be supported on the lining of the walls, but on the outer brickwork exclusively. Blowers, fans, and charging devices should under no circumstances be supported on the furnace walls.

The softening and melting influence of the furnace temperatures is to a large degree neutralised by the cooling effect of the outside temperatures, the degree of influence depending upon the difference of temperature acting on both sides of the wall and upon its thickness, as well as upon the heat-conducting properties of the refractory material. If for a certain inside temperature the walls are too heavy, the inner surface will commence to melt off until the equilibrium is reached. Furnaces exposed to very high temperatures should for this reason not be too heavily walled, while the roofs should not be covered with ashes and sand, as is often practised "for the sake of economy."

Badly-Shaped Bricks Detrimental.

The softening points of refractories are decidedly lowered by using badly dressed, uneven, and rough bricks. The very strong pressures exerted upon the bricks are then concentrated upon the protruding points of the surfaces, which, under the influence of the exceedingly heavy load, will soften at a correspondingly low degree of temperature, causing the premature softening of the neighbouring parts of the surfaces and the gradual destruction of the entire brick. The usual method of making tight walls by laying the bricks with heavy layers of cement is to be condemned. The surface of the bricks must be dressed properly, and the smooth and even bricks laid with but a very thin layer of cement.

Liability to Spalling.

The degree of resistance of the refractory bricks against sharp and sudden changes in temperature is determined by the structure and density, as well as by the conductivity of heat and the co-efficient of expansion of the bricks. Of all the refractories commonly used, this resistance is most perfectly developed in the fireclay bricks of modern make. Magnesite bricks crack and spall at comparatively insignificant changes of temperature, while even the silica bricks are considerably more sensitive than fireclay bricks. The following are comparative figures of the specific sensitiveness of the common refractories, magnesite being taken as 100:—Magnesite bricks, 100; silica bricks, 75; chromite bricks, 42; zirconia bricks, 16; bauxite bricks, 13; fireclay bricks, 8 to 12; and carborundum bricks, 2.

The higher the degree of porosity of the bricks the higher is their resistance against changes in temperature; above a certain degree of porosity, however, the strength of the material is considerably weakened.

The influence of the quartz or silica contents upon the resistance of the fireclay bricks has recently been successfully determined by Douda, Schurecht, and others, who were in agreement that, above a certain small percentage, silica contents tend to decrease the resistance of fireclay bricks against abrupt changes of temperature. Experiments carried through by Bales confirmed the fact that fireclay bricks with 45 per cent. of clay are most resistant, while such containing 30 per cent. of clay and 68 per cent. of silica are very sensitive towards temperature changes.

This detrimental influence of larger amounts of free silica may be explained with the comparatively very high co-efficient of expansion of the silica as well as by the changes of volume caused by the transformation of the natural quartz form of silica into cristoballite and tridymite, and particularly the transformation of the alpha modification of these forms into the beta modifications. In burning the fireclay bricks, 75 to 80 per cent. of the quartz contained is transformed into cristoballite and tridymite, the exact degree of transformation being determined by the duration and temperature of the process. Although the transformation is accompanied by an increase of volume of the quartz of about 20 per cent., the transformation of the remaining 20 to 25 per cent. of quartz and semi-quartz will hardly cause appre-

ciable deterioration of the bricks. Much more important, however, is the transformation of the alpha forms of quartz and cristoballite into the respective beta modifications. While the transformation of the quartz takes place at 580 deg. C., cristoballite is transformed at a temperature of 222 deg. C. Both transformations proceed rather sharply, and are accompanied by a considerable increase of volume of the silica particles. Wherever, therefore, these two crystalline forms of silica are present in considerable quantities, the fireclay bricks will tend to cracking and spalling if the critical temperatures in question are frequently passed too rapidly.

The transformation of the third crystalline form of silica, the tridymite, into the beta modification takes place gradually and without appreciable increase in volume, causing practically no chipping and spalling if present in sufficiently large quantities. Large percentages of tridymite in fireclay bricks, therefore, influence but little the resistance of the material against temperature changes. Changes in temperature above 654 deg. C. do not appreciably influence fireclay bricks of any sort.

The resistance of the fireclay bricks against temperature changes is also much influenced by the degree of porosity as well as by the grain size of the material. The coarser the grain the more resistant the bricks will be. Fireclay bricks with grains of 3 mm. diameter are, according to Kirkpatrick, three times as resistant against sudden temperature changes as bricks with grains of below 0.8 mm. diameter.

Cementing Desiderata.

Bricks should be laid in as dry and as thin a layer of cement as possible. Heavy layers of wet cement cause the absorption of large quantities of water by the bricks which upon drying and heating of the furnace must be expelled, the steam formed weakening the structure considerably and causing chipping and spalling. The bricks of the lining of the hearth and walls, as well as the roof, should therefore be merely dipped into a dilute emulsion of the cement and laid in their place. In American practice the bricks of the hearth and the walls, particularly of large furnaces, are frequently laid in perfectly dry fireclay mortar. Drying and heating of the furnace should proceed as gradually as possible, but the temperature should then be raised until glazing of the fireclay bricks results. As a rule the furnace is brought up to a temperature of 1,290 to 1,480 deg. C. in about five to six days, while this temperature is maintained 12 to 24 hours. The cooling of the furnaces should proceed correspondingly slowly.

Painting Brickwork Faces.

The advantages of glazing the bricks, particularly as regards the chemical inertness and the resistance against sudden temperature changes, have often caused their artificial production by painting or plastering the walls with certain substances of low melting points. Attention should be called to the fact, however, that the use of most substances ordinarily employed for this purpose—as, for instance, the different alkalies—should be abstained from, since these tend to reduce more or less the softening points and the resistance of the bricks against erosive influences. The formation of glassy layers should also be avoided since, on account of the different co-efficients of expansions, these will crack very easily.

The conductivity of heat of refractories depends upon several factors. Strongly burned, dense bricks are more conductive than porous and pervious material, the conductivity of new bricks differs from that of old bricks used more or less, and impregnated with slags and metallic vapours. Also the number and width of joints and the kind and density of the mortar used are of some influence.

The coefficients of thermal conductivity of fireclay bricks have been determined by Hodsman, Cobb and Dudley, who found that the thermal conductivity C at the temperature t is

$$Ct = 0.00155 + 0.25\ 10^{-5}t,$$

where C = gramme calories for 1 sq. cm. per second through a plate of 1 cm. and a difference of temperature of 1 deg. C.

The values calculated are but theoretical, of course, and are more or less influenced by the factors above enumerated.

The resistance of new, unused refractories against mechanical stresses is of but minor interest to the metallurgist, since this is almost exclusively determined by the methods of laying and the treatment of the furnace under actual working conditions. All influences tending to increase spalling and chipping of the bricks, as, for instance, faulty drying of furnaces, rapid temperature changes, etc., will also decrease the resistance of the bricks against mechanical stresses. While new bricks are usually rather sensitive against shocks, etc., their resistance will increase rapidly after having been in use a short time. A fireclay brick saturated with slag and metals is, in the hot or cold state, practicably insensitive towards mechanical stresses, as, for instance, the impact of falling slabs of metal, scratching and falling of working tools, etc.

The chemical inertness of refractory bricks must be directed against the strongly slagging influences of partly fused metallic oxides and against the slags, as well as against the corrosive effects of metallic vapours and flue gases. The chemical neutrality of fireclay bricks makes this material particularly suitable for metallurgical purposes, although if high in silica its chemical inertness towards basic influences is correspondingly decreased. Fused metals do not attack fireclay bricks below a temperature of 1,315 to 1,370 deg. C.; the same is true of acid substances, slags, etc., particularly if the bricks are rich in silica. Atmospheric oxygen does not attack fireclay bricks at any temperature.

Cupola Walls and Iron Oxide.

Furnace gases high in carbon monoxide, on the other hand, are quite corrosive to fireclay bricks rich in iron oxide if this oxide is present in the free or but weakly bonded condition, and if, in addition, the surface of the brick is sufficiently open to permit of the entrance of considerable quantities of the gas into the interior. The iron oxide is reduced to some lower form of oxidation or to the metallic state which, in turn, reduces the hot carbon monoxide gases to carbon. This active carbon deposited in the pores of the brick is regasified again and exerts a blasting action on the structure of the bricks, giving rise to the formation of haircracks and, finally, to chipping and spalling of the refractories. The corrosive action of the firing gases is, of course, more or less intensified by corrosive chemical gases formed by the different metallurgical processes. The more finely grained and evenly distributed the iron oxide the less pronounced will be the corrosion of the fireclay bricks from this reason. Insufficiently burned and porous bricks are more strongly attacked than strongly-burned and dense material. Fireclay bricks for metallurgical purposes should therefore be as low as possible in iron oxide, and should contain this in the highest state of division.

The resistance of the fireclay bricks against the different corrosive influences, while in the first place governed by their own chemical nature, depends to a large extent upon the absorptive power of the bricks for gases, slags, and solids. This, in turn, is determined by the degree of porosity. The more porous the material the deeper the penetration by the foreign agents and the more rapid will be the destruction caused. Since a certain degree of porosity is, for other reasons, definitely necessary, however, the pores of the surface should be closed either by fusion, that is to say, by glazing with some fusible material or under the influence of intensive heat, or by closing up the pores with some chemically inert substances. This may be effected by dipping the bricks into the dilute cement emulsions of correct composition or by washing the walls with a correspondingly prepared solution. In American practice the furnace walls are frequently covered with a layer of cement about 1 in. thick and particularly suited to the condition of the process as well as to the nature of the bricks covered. Painting the lining with tar or heavy tar oils, or dipping the bricks into tar oil, has also been recommended frequently. Part of the oil will enter the pores, and upon heating the furnace forms a coke

which is equally resistant against the heat as against the various corrosive agencies.

Jointing.

Particular attention should be paid to the condition of the joints of the lining. If these are not entirely closed by suitable mortar they will expose a much larger surface of the brick to the corrosive influences of gases and vapours. Open joints located in the hearth of the furnace possess the much more serious disadvantage of allowing the metal to penetrate between and below the bricks, often leading to the washing out of large parts of the hearth. This danger is frequently avoided by melting sufficiently large quantities of very refractory slag in the furnace, which is absorbed by the bricks and penetrates into the joints, making the hearth tough and strong. Open joints are primarily due to badly dressed bricks and to the use of heavy layers of unsuitable composition. Recourse is frequently had to the use of larger sized bricks which, while not entirely eliminating the danger, will at least cause a corresponding reduction of the total number of joints.

Of all the refractories commonly used, fireclay bricks are least subject to change of volume and shape under actual working conditions. Well-burned fireclay bricks of good quality are subject only to the normal coefficient of expansion, amounting to 0.59×10^{-5}.

More pronounced expansions, similar to those suffered by silica bricks, may be caused only if considerable quantities of silica are present. As a rule, however, this expansion of the silica grains in fireclay material will tend to cause the formation of haircracks rather than an appreciable expansion of the fireclay brick as a whole.

Notes on Annealing Brass.

By "Celsian."

Losses of brass during annealing are partly due to direct oxidation of the solid metal forming a scale. This loss depends on the composition of the alloys, on the temperature to which they are subjected, and to the volume of the gases employed. Zinc in copper alloys volatilises very rapidly (hence the practice of leaving the addition of zinc until about a few minutes before casting, in order to avoid the excessive loss which otherwise would occur. With a gas-annealing furnace the volatilisation experienced in a given time increases in proportion to the increase in volume of gas employed, and to the speed with which it is spread around the metal. As the amount of metallic vapour which a gas may sustain is constant for a given temperature and pressure it will readily be realised how great an influence the volume of gas exerts on volatilisation. It is theoretically maintained that the volume, and not the composition of the gas used, most materially effects volatilisation, but this does not apply in practice to an oxidising atmosphere where the metallic vapours become converted to oxides. This is exemplified during the usual heat-treatment of brass, when the oxidation of zinc and copper readily occurs.

A substantial loss of brass is inevitable when copper and zinc alloys are subjected to a lengthy heat-treatment at a given temperature with a considerable volume of gas. When these latter factors are reduced to a minimum, the loss of metal experienced will be correspondingly decreased.

When the metal is placed in a covered crucible, as in melting brass, or in a muffle furnace, fired outwardly, a substantial reduction in the volume of tangible neutral gas may be arrived at. This advantage is forfeited, however, where use is made of a furnace constructed with considerable air space, as the frequent opening of the door admits air around the metal in the muffle. Another disadvantage of an outwardly fired muffle is the unavoidably irregular heating of the metal which occurs much more slowly in the centre than it does at the hot walls of the muffle. Consequently the heat efficiency secured from an outwardly fired muffle is low, and a lengthy period is necessary to bring the metal to the requisite temperature.

Whilst volatilisation decreases the weight of a metal, oxidation increases it, and both factors, during commercial operations, depend more on the amount of surface of the piece under treatment than on its weight. The claim is made for the use of neutral coal gas in a specially-constructed furnace, that the loss sustained by volatilisation, during heating, is compensated for by the protective coating formed by oxidation.

Gas of the requisite composition may be obtained from partial combustion of natural gas, petroleum or coal gas. Gas of about the same composition might be obtained from producer gas as it comes hot direct from the producer. This would necessitate particular care being bestowed on the producer to obtain it, and its composition might prove variable.

The furnace used is heated inside as well as externally. A mixture of gas with air in varying proportions according to the temperature desired, is burned at the opening into the muffle, when the products of incomplete combustion travel over the metal, through the muffle and out at the other end. There they meet and mix with a secondary volume of air sufficient for complete combustion and return, circulating around the outside of the muffle.

Where steel castings have to be annealed it is shown that a temperature of 1,205 deg. C. may be maintained in the muffle and that traces only of oxidation occur in either iron or steel at that temperature by subjecting them directly to gases formed by one volume of enriched coal gas combined with approximately two volumes of air. The heat treatment of steel necessarily requires a higher temperature than brass, but this class of muffle proves equally applicable to brass and copper. When subjected to the action of products obtained from burning enriched coal gas with a deficiency in the amount of air, copper is not oxidised although the amount of gas and air required differs according to the temperature desired. A temperature as great as 1,635 deg. C. may be used with gases formed of three volumes of air and one of coal gas for annealing commercial copper or brass without detelerious effect. In fact the bright surface is hardly tarnished; neither appreciable oxidation nor change of weight occurring.

Pieces of metal placed in the muffle are swiftly and evenly heated with a minimum loss of weight. When brass 70:30, is heated almost to melting point for an hour, the amount of zinc removed only amounts to a layer as thin as 0.003 of an inch. Copper can be heated in the foregoing manner to any temperature reaching almost to its melting point without appreciable scale formation. There is every reason to believe that, given a proper design of furnace the commercial value of this process would prove eminently successful, especially when conducted on a large scale.

British Shipping.—In the course of a paper on "Statistics of British Shipping," read at a meeting of the Royal Statistical Society on Wednesday, in the rooms of the Society of Arts, Mr. H. W. Macrosty said that at the end of 1918 the British mercantile fleet was about one-sixth below its pre-war strength, but to-day it had practically recovered its position. The addition of new vessels was proceeding at only about three-fourths of the pre-war rate, and the increase of our tonnage was in part due to the assignment to this country of over 2,000,000 gross tons of enemy shipping. Since 1918 over 3,000,000 net tons of shipping had been sold to foreigners, over 30 per cent. of which had gone to Italy and Germany. The breaking-up of old ships had gone on at a very slow rate. Since pre-war days the smaller class of ocean-going steamer, between 1,600 and 5,000 gross tons, the "tramps," had decreased heavily in number and tonnage, while "cargo liners," between 5,000 and 7,500 gross tons, and "passenger-liners," over 7,500 gross tons, had largely increased. The relation of net to gross tonnage showed a general increase in carrying capacity, due mainly to structural improvements, and as the number of large motor vessels grew this increase would be more noticeable. Study of the age-constitution of the ships showed a great growth in newer vessels over 5,000 gross tons, so that the efficiency of our merchant vessels was to-day greater than before the war, but the decline in shipbuilding contained a danger for the future.

XUM

Company Meetings.

Babcock & Wilcox, Limited.—The twenty-seventh annual meeting was held in London recently, Sir John Dewrance presiding. In moving the adoption of the report and accounts the chairman said it was a great source of pride that the board could submit to the shareholders such a satisfactory balance-sheet at the present time when so many other engineering companies were not in such a favourable position. He hoped that the present increasing state of trade would not be checked by labour troubles. Referring to the action of trade unions in deciding to take a strike ballot as to whether they are to strike for increased wages, he said he hoped that at the last moment something could be done that would check this stoppage of work. "We are faced with the difficulties of the coal question," he added, "and your company cannot carry on for any length of time without fresh supplies of coal, and that looms very black in the future but if we can succeed in controlling these influences there is every promise that the state of trade in the future will be even more satisfactory than in the past."

Coltness Iron Company, Limited.—Mr. Peter Rintoul, the chairman, in moving the adoption of the report at the annual meeting in Glasgow, said the profit earned was some £50,000 less than the profit of 1924. There was a continuous drop in the price of coal during 1925, amounting on the average to 2s. 2d. per ton on all coal raised in Scotland. In the case of their company the fall in the average price received was greater, because their production in 1924 was well sold, and the running out of these good contracts accentuated in their case the serious drop in the average price per ton. Coal was not their only business, and a considerable portion of their profit was derived from their cement, their iron and steel foundries, their brickworks, and certain other minor industries. The outlook in these industries was not to-day quite so good as it was a year ago, and most of the business was got at keenly competitive prices. The whole of the iron furnaces were still out of blast, and so far the directors had seen no inducement to relight them. Trade and prices were so poor that to-day only 20 furnaces were in blast in Scotland, whereas in 1913 the average number in blast was 86. The Warwickshire Coal Company had continued to make profits, and they had benefited in this year's accounts from the receipt of the first dividend paid by that company. They had received no dividend during the year from the Bacares Iron Ore Mines, Limited, which had been unable to earn profits owing to the very poor demand and prices for iron ore. Referring to the balance-sheet, he remarked that the issue of the new ordinary shares made last year had placed the company in a strong financial position, which, in his judgment, was most important in the present difficult times.

Vickers, Limited.—The fifty-ninth annual meeting was held at Sheffield on April 15. Mr. Douglas Vickers (president) was in the chair, and in proposing the adoption of the report, said: The results of the past year's working show a profit of £420,973, sufficient to pay preference dividends and leave a margin of £18,275, which has been added to the carry-forward. The works have been well maintained, though no depreciation beyond certain special items has been provided. In the opinion of the directors, it was not necessary to make any further reduction last year on the low value of assets so recently taken as a basis on the recommendation of the advisers. Considerable sums have, however, been written off for depreciation in the accounts of the subsidiary companies. Interest on debentures was deducted in accordance with our usual practice before the figure given as profit was reached. As regards the extent to which the company's various interests contributed to the results of the year, Sheffield did fairly well, though the return from the armament side there was not so good, due to want of orders. Barrow made both ends meet, and something over, a result which seems creditable in view of the general state of the shipbuilding trade; Erith and Dartford works showed a fair profit; Crayford suffered a small loss, due to the small volume of work in this large war factory; and Weybridge Aviation Works did well. Cooke, Troughton and Simms justified their recent reorganisation by making profits, as did also the Variable Speed Gear Company. This leads me to say here that one of the results of writing down the assets under the capital reduction is that the board will probably decide to reorganise similarly some of our other subsidiary companies and bring their nominal capital down more in accordance with the values at which they now stand in the parent company's books. Our connections in Italy Roumania and Spain all did well, but the dividends of the first two are distributed unfortunately in depreciated currencies. As to the industrial side, the Metropolitan Carriage and Wagon Works have been fairly well employed, and have paid the same interim dividend as last year (their financial year ends at March 31). Our brass and duralumin works, James Booth & Company, did very well on a small capital. Wolseley Motors, Limited, had a bad year ending September 30 last, and are now feeling very seriously the setback in the motor-car business which began last December. On the purely electrical side, the Cable Works (Glovers) did well, and have proved the advantage of recent extensions. Metropolitan-Vickers Electrical Company, as is known, paid 8 per cent.—a very creditable result considering the depression of the home trade. Fortunately, they have for some time past cultivated foreign business very carefully, with the result that considerably over half their orders came from abroad. It is of interest also that those foreign orders comprised some of the heaviest and most important pieces of machinery made in the country.

Contracts Open.

Chatham, May 29.—Supply and delivery of about 2,530 tons of cast-iron pipes and specials, for the Rochester and Chatham Joint Sewerage Board. Messrs. W. H. Radford & Son, engineers, Albion Chambers, King Street, Nottingnam. (Fee £3 3s., returnable.)

Dundee, May 3.—Supply of 170 tons of 12-in. internal diameter cast-iron pipes, and, alternatively, 1,320 yards of 12-in. internal diameter steel tubes, for the Dundee Water Commissioners. Mr. G. Baxter, jun., engineer and manager, 93, Commercial Street, Dundee.

Scarborough, May 10.—Manufacture and delivery of about 1,000 tons of cast-iron regular pipes and specials of 15-in. and 13-in. diameter, together with a small tonnage of 9-in., 6-in., and 3-in. regulars and specials, for the Corporation. Mr. S. Jones, town clerk, Town Hall, Scarborough. (Fee £2, returnable.)

Johannesburg, June 10.—Supply and delivery of one steam Titan crane, capable of lifting concrete blocks weighing 30 tons (2,240 lbs.), for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 3,024.)

London, E.17, June 2.—Supply and erection of a crushing, screening and mixing plant for the manufacture of clinker asphalt, for the Urban District Council. Mr. G. W. Holmes, engineer and surveyor, Town Hall Annexe, Orford Road, Walthamstow, E.17.

London, S.E.1, May 11.—(4) Hydraulic buffer stops; (5) oil-engine pumping sets for Kapadvanj water supply; and (6) boiler, steam engine and pumps for Poona waterworks, for India Store Department. The Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1.

London, S.E.1, May 11.—(1) Motor converter, La Cour type, 200-kw., 6,000 a.c./440/220 d.c.; (2) locomotive crank axles; (3) buffer parts; (4) engine buffers and axle boxes; and (5) steam travelling crane, for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. Forms of tender obtainable from above (tenders due on May 11 for Nos. 1 and 5, and on May 4 for Nos. 2 to 4).

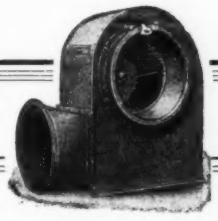
Company Reports.

Hadfields, Limited.—Dividend on ordinary shares, 3 per cent., less tax.

Manganese Bronze and Brass Company, Limited.—Brought forward, £10,485; adverse balance, £9,884.

John I. Thornycroft & Company, Limited.—The directors of John I. Thornycroft & Company have decided to pay an interim dividend of 3 per cent. on the Cumulative Preference shares in respect of the financial year ending July 31 next, less tax.

The large steel tube works, which is the only one of its kind in the North of England, and which has been under construction for the last year at the South Durham Steel and Iron Company's Malleable Works, Stockton-on-Tees, is expected to start manufacturing at the beginning of May. The company have been successful in securing some important contracts, including the supply of several miles of 42-in. steel pipes for the third instalment of the Vyrnwy water supply for the Liverpool Corporation, together with 24-in., 30-in. and 40-in. steel water pipes for the Manchester Corporation, and also a section of the steel piping required for the new undertaking of the Dublin Corporation Water Works. All the pipes for these contracts will be lined with the "Talbot" patent hydro-carbon process. The first section of the plant is capable of manufacturing up to 72-in. diameter tubes up to 30 ft. long.



40 Years' Experience in the Design & Construction of Fans

for

Heating and Ventilation of Buildings, Mines and Ships,
High Pressure Blast for Forges, Furnaces and Cupolas,
Mechanical Boiler Draught,
Fume and Steam Removal,
Dust Removal and Collection,
Cooling and Drying Plants

means **Expert Knowledge, High Efficiency, Reliability & Good Service**

Davidson's the TRADE SIROCCO MARK Fan Makers

have an experience covering hundreds of different industries and hundreds of different uses, and they can furnish a Sirocco Fan for every purpose for which a fan can be employed.

Solve your fan problems by using the Sirocco Service.

DAVIDSON & Co. LIMITED

SIROCCO ENGINEERING WORKS - BELFAST

LONDON - BIRMINGHAM - CARDIFF - BRISTOL MANCHESTER - GLASGOW - NEWCASTLE

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863

JAS. DURRANS & SONS, LTD.

PHOENIX WORKS, PENISTONE, near SHEFFIELD.

Telephone:
21 PENISTONE.

Telegrams:
"DURRANS, PENISTONE."

Manufacturers of

FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES.
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

Trade Talk.

Fescol, Limited, Penarth Street, Canterbury Road, Old Kent Road, S.E.15, have removed to 101, Grosvenor Road, Westminster, S.W.1.

Colonel R. E. B. Crompton has gone to the United States to attend the conference of the world's electrical engineers in New York.

Wm. Beardmore & Company, Limited, have an order from the London and North-Eastern Railway Company for twenty suburban tank locomotive engines.

Mr. A. Campbell Swinton, electrical and consulting engineer, 66, Victoria Street, Westminster, S.W.1, is retiring, but will continue special consulting work at 40, Chester Square, London, S.W.1.

The output of pig-iron in the United States in March amounted to 3,435,525 tons of 2,240 lbs., as compared with 2,923,850 tons in February. Last month's output was the highest since March, 1925, when the quantity produced was 3,571,422 tons.

The tender of Sir William Arrol & Company, Limited, Glasgow, for the construction of the new bridge over the Wear, has been accepted by the Sunderland Corporation. The company undertake to complete the structure in 32 months at a cost of £230,339.

A report from Rio de Janeiro states that Dr. Mallo Vianna, President of the State of Minas Geraes, has signed a decree authorising a contract with the Metropolitan Vickers Electrical Export Company for the electrification of one of the lines of the Western of Minas Railway.

The British Empire Steel Corporation's rail mill at Sydney, Nova Scotia, which has been working until recently on Canadian National Railway standard orders, has adjusted its rolls to the requirements of the New Zealand railways, and is now engaged in rolling the last 7,000 tons of a 10,000-ton order, which will keep the plant on single shift until the middle of April.

Ferranti, Limited, Bush House, London, W.C.2, have recently received two orders from Australasia, namely, from the Sydney Municipal Council: 6,10,000 kva., three-phase transformers, 33,000 volts; Public Works Department, New Zealand: 7-5,000 kva., single-phase transformers, for use as 15,000 kva., three-phase groups, 110,000 volts. The approximate total value of these two orders is £40,000.

Herculeum, Limited, Steam Fittings Company, Limited, S. T. Taylor & Sons, Limited, Lafarge Aluminous Cement Company, Limited, John Kenyon & Company (Sheffield), Limited, Matthew J. Hart & Sons, Limited, Switchgear & Cowans, Limited, John Hetherington & Sons, Limited, Expanded Metal Company, Limited, Corfield, Limited, and William Cooke & Company, Limited, have joined the Federation of British Industries.

Metro-Vick Supplies, Limited, a branch of the Metropolitan-Vickers Electrical Company, Limited, have opened at 147, Charing Cross Road, W.C., their new premises devoted to the sale and distribution of small electrical accessories for lighting and heating, etc. The new building is exceedingly well arranged and equipped for the efficient handling of this class of trade, which hitherto has been conducted from Westminster. Realising the desirability of a more central position for their accessories department, the management decided to transfer it to Charing Cross Road, where it occupies a prominent position adjacent to Oxford Street. The change-over from Westminster to the new premises naturally was no small undertaking, and it speaks well for the organisation that the task was accomplished between Friday and Monday morning, the whole of the enormous stocks having been transferred during the week-end.

The new Congella Power Station, Durban, South Africa, will eventually cost over £500,000, and it is possible that the full equipment up to 48,000-kw. normal output may be undertaken immediately, although actual orders have so far only been placed for the first section of 24,000-kw. As regards the entire contract for the steam generation plant this has been secured by International Combustion, Limited, of London, and the main equipment consists of four "Babcock & Wilcox" water-tube boilers, each of 7,150 sq. ft. heating surface, corresponding to a normal evaporation of 60,000 lbs. of water per boiler hour, with 80,000 lbs. long overload. The working pressure is 270 lbs. per sq. in., and the final temperature of the superheated steam 700 deg. Fah., while the normal coal consumption will be 7,200 lbs. per hr., with a maximum of 10,000 lbs., all these figures being based on an average inlet temperature of the feed-water of 210 deg. Fah. "Lopulco" pulverised fuel on the usual principles will be equipped throughout, with overhead bunkers for the crushed coal, continuous vertical gravity driers, Raymond pulverisers, cyclone separators, motor-driven variable speed fuel feeders, and modern fish-tail burners. Also the combustion chamber in each case will be 5,200 cub. ft. capacity, while the two side walls are to be built up of the Murray-Usco water-cooled fin tubes, corresponding to a total of 420 sq. ft. heating surface.

For the inauguration of the all-steel train a party of Colonial representatives, railway experts and contractors, etc., journeyed from London to Birmingham in coaches, which are constructed entirely of steel. This is a pioneer move on the part of the L.M.S. Company, who hope, as the result of their experiment, to bring all-steel railway coaches into general use on their system, and at the same time assist British and Imperial industries. The first portion of the order that the company has placed consists of 77 cars, and these will be delivered by the end of May. During the summer they will be used partly for long-distance week-end traffic. The cars are being built by the Birmingham Railway Carriage and Wagon Company, Limited, Smethwick; Cammell, Laird & Company, Limited, Nottingham; the Leeds Forge Company, Limited, Leeds; and the Metropolitan Carriage, Wagon and Finance Company, Limited, Saltley. Mr. W. L. Hichens (director of Cammell, Laird & Company, Limited, and the L.M.S.) presided at a luncheon and expressed regret at the absence of Sir Guy Granet (general manager of the L.M.S.), who, he said, held the view that in a few years' time, at the present rate of consumption, there would be a timber famine in the world. What appealed to Sir Guy in the matter of the all-steel coaches was that their construction employed British industries.

Contracts for 26 locomotives and over 400 wagons of various types have been placed by overseas railway companies with British manufacturers, while inquiries are circulating for tenders for six articulated locomotives of either the modified Fairlie, the Garratt, or the Kitson Meyer designs, states "Modern Transport." The latter inquiry emanates from the San Paulo (Brazilian) Railway Company, who have this week placed with the North British Locomotive Company, Limited, of Glasgow, an order for six 2.8.4 superheated tank engines, which are to be delivered in July next. The majority of these orders have been placed by the Rhodesia Railways, Limited, and comprise 20 4.8.2 locomotives and tenders (12th class) from the North British Locomotive Company, Limited, 100 45-ton high-sided bogie wagons from the Metropolitan Carriage, Wagon & Finance Company, Limited, Saltley Works, Birmingham, and a similar number of the same type from Cammell, Laird & Company, Limited; 25 bogie goods guards vans from Cravens Railway Carriage & Wagon Company, Limited, Darnall, Sheffield; three enginemen's cabooses from Hurst, Nelson & Company, Limited, Motherwell; and five 3,500-gallon and one 5,000-gallon tank wagon from the Blake Boiler, Wagon & Engineering Company, Limited, Darlington. The Birmingham Railway Carriage & Wagon Company, Limited, who have recently delivered 25 bogie covered cattle wagons to the Rhodesia Railways, Limited, have now received orders for 100 similar vehicles and for 100 bogie covered goods wagons, each with a carrying capacity of 35 tons. Inquiries are also being made for four passenger brake vans for the same country. Contracts placed during the last few days by railway companies in this country include one for 525 tons of copper plates, which the London & North-Eastern Railway Company has divided between the British Copper Manufacturers, Limited, London Wall Buildings, E.C.2; Elliots Metal Company, Limited, Birmingham; P. & W. M'Lellan, Limited, Glasgow; J. Bibby, Son & Company, Limited, Liverpool, and T. Bolton & Sons, Limited, Widnes.

Obituary.

Mr. J. Ward, manager for nearly thirty years of the Staveley Coal and Iron Company's boiler department, died recently, at the age of seventy.

Mr. R. H. Neal, founder and managing director of R. H. Neal & Company, Limited, commercial and industrial engineers, Plant House, Longfield Avenue, Ealing, London, W.5, died suddenly on Saturday, April 17. The company will continue under the personal guidance of his sons, Mr. N. R. Neal and Mr. B. H. Neal, who have been closely associated with the deceased for the past seven years as departmental managers.

Mr. E. L. Ahrons died recently at his residence, Corporation Oaks, Nottingham. The deceased, after leaving college, became an engineering pupil at the Swindon Locomotive Works. In 1890 he was appointed chief draughtsman to Fleming, MacFarlane & Company, Middleton, and later engineer and manager of the Egyptian Government workships. He returned to this country about 27 years ago, and subsequently became engineer to Henry Simon, Limited, Manchester.

Clegg, Highcock & Company have removed to 8, Drury Lane, Water Street, Liverpool.

Telegrams : "IRON BILSTON."

West Midland Refining Co.,

Bilston.

COLD BLAST IRONS

for Chilled Castings.

Chills and analysis guaranteed.

CHARCOAL

REFINED HEMATITES

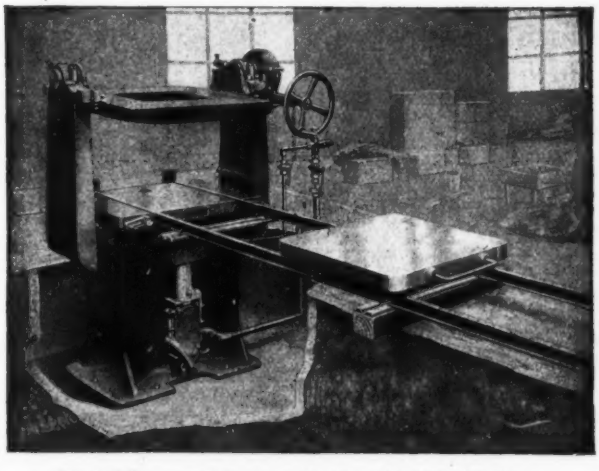
for Malleable Castings.

BRITISH MOULDING MACHINES

AND FOUNDRY EQUIPMENT.

INTERNATIONAL FOUNDRY TRADE EXHIBITION

ROYAL AGRICULTURAL HALL, LONDON.



No, 1. "Coventry" Turnover Jar Ram Moulding Machine.

The most efficient machine, built to stand rough usage

JUNE 10 to 19, 1926. SEE OUR STAND No. 5, ROW E, CENTRE OF HALL.

WRITE FOR CATALOGUE TO—

Britannia Foundry Company, Ltd.

COVENTRY, ENGLAND.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—In this critical stage of the negotiations for peace in the mining industry it could hardly be expected that business in the Cleveland iron market would be more than nominal, and during the current week, accordingly, the sole subject of discussion on 'Change has been naturally centred on the probable outcome of the varying phases of the protracted conflict, and the effect, if any, of Government intervention in the dispute. At the moment the Cleveland ironmakers have no surplus, and, for their part, are quite unwilling to consider forward contracts. The period of suspense before a settlement of the trouble, one way or the other, cannot, however, now be of long duration, and in the meantime sellers adhere to recent price levels. No. 1 is 73s., No. 3 G.M.B. 70s. 6d., No. 4 foundry 69s. 6d., and No. 4 forge 68s. 6d. per ton. All these are for export, home quotations being 6d. per ton less.

Stocks of hematite on Tees-side at present are plentiful, and, with only a limited volume of export trade, values continue to decline. At recent markets sellers still quoted 76s. per ton for East Coast mixed numbers, with No. 1 on offer at 6d. per ton more, but it is quite understood that these figures can be substantially shaded for any attractive orders. On the North-West Coast, Bessemer mixed numbers are now quoted at £4 2s. 6d. c.i.f. Welsh ports, £4 5s. to £4 7s. 6d. per ton delivered at Glasgow, £4 8s. to £4 10s. per ton delivered at Sheffield, and £4 12s. to £4 14s. per ton delivered at Birmingham.

LANCASHIRE.—In this area there has so far been no indication of lower prices for foundry pig, although there are some consumers who hold the view that these are due. There has been, however, a slight easiness in some of the higher-priced Derbyshire irons, but it has not been very pronounced, the present range being about 75s. to 75s. 6d. per ton, delivered into the area, for No. 3 pig. Staffordshire and Lincolnshire makes show no change, and are still offered at round 76s., with Scottish No. 3 and West Coast hematite both at about 94s.

THE MIDLANDS.—Slightly more active conditions have been experienced in the Birmingham market of late, but few orders of any bulk for foundry pig have been booked, and, with the contracts made earlier in the year now on the last stages of completion, quite a number of large consumers is buying from hand to mouth, and possibly will continue in this manner until the industrial outlook is a little more settled. Ruling quotations are as follow:—Derbyshire No. 3 foundry, 67s. 6d.; Staffordshire No. 3 foundry, 67s. 6d.; Northants No. 3 foundry, 63s. to 63s. 6d.

SCOTLAND.—Business in the Scottish pig-iron markets is virtually suspended, pending a solution of the miners' trouble. Consumers are inclined to run down stocks, rather than take in extra supplies, in case of a coal stoppage. There is, therefore, very little business being done, and prices are unchanged at 76s. per ton, f.o.t. furnaces for No. 3 Scotch foundry. This is a comparatively cheap price compared with Middlesbrough No. 3, which is still maintained at 75s., f.o.t. Grangemouth.

Finished Iron.

Reports from the various manufacturing centres indicate little improvement in respect to bar iron except that bolt material is being quoted by the South Staffordshire works at £9 15s. It is not admitted, however, that this has brought much business. Of course, the price is still a long way off the figure for Continental No. 3, which is freely quoted at £6 10s. to £6 15s. delivered, and there is a fair amount of business being sent abroad at this figure. Crown iron is still being quoted round about £11 to £11 5s. in Birmingham, but business of any note is entirely lacking, and all the ironworks are operating part time. The makers of marked bars are certainly a little better off, but they have anything but a good order book. Quotations for this grade are £14 at makers' works. There is a fair amount of business passing for tube strip at the basis price of £12 10s.

Steel.

In the Sheffield market there is a good deal of hesitation, and sales of billets, both acid and basic, are on a smaller scale than of late. Steel manufacturers are keeping their stocks as low as they reasonably can in view of the industrial position. Quotations have not changed at £10 10s. for Siemens acid billets, up to £5 15s. for soft basic, £8 2s. 6d. for medium, and £8 12s. 6d. for hard, all delivered. So far production of open-hearth steel is keeping up well, as is that of Sheffield's special qualities. Crucible production is rather less in demand. Tinplate makers are still compelled to compete keenly for orders for early delivery, and transactions have taken place rather freely at 19s. 1½d., and even a shade less has been taken in some cases. This is very unsatisfactory, and makers state they have no margin of profit at all.

Scrap.

There is little or no improvement in the position of iron and steel scrap on the Lancashire markets, and prices, particularly in the case of mild steel, are easy. Wrought-iron is quoted at about 65s. per ton, ordinary machinery cast-iron scrap at round the same figure, textile machinery scrap at round 70s., and mild steel scrap at from 52s. 6d. to 55s. per ton, on trucks Manchester. In Scotland, good, clean heavy shovelling turnings remain unchanged at 52s. 6d. to 53s. 6d. per ton, and clean cast-iron borings around 50s. per ton. First-class heavy machinery cast-iron scrap, in pieces not exceeding 1 cwt. and suitable for foundries, is now a bit of a drug, as foundries are not buying to any extent, and some holders are having difficulty in finding an outlet even at 71s. 3d. per ton. Ordinary heavy cast-iron scrap to the same specification is in a similar position at 5s. per ton less.

Metals.

Copper.—With values maintained around the £57 level, the market for standard copper is practically unchanged, with a daily turnover substantially below the normal average. In America also the position has weakened, and spot electrolytic has been marked down. Up to the present, domestic buying has been fairly satisfactory, but latterly the demand has slackened, though manufacturers are considered to be very lightly stocked, and have yet to cover the bulk of their spring requirements. Current quotations:—*Cash*: Thursday, £57; Friday, £57; Monday, £57 10s.; Tuesday, £57 5s.; Wednesday, £57 2s. 6d.

Three Months: Thursday, £57 17s. 6d.; Friday, £57 15s.; Monday, £58 7s. 6d.; Tuesday, £58 2s. 6d.; Wednesday, £57 17s. 6d.

Tin.—In this section of the base metal markets values also have declined some £6 below last week's figures for standard, notwithstanding an improvement in recent statistical returns. Stocks of tin landing and afloat in Europe and America, according to Messrs. Ricard & Friewald's statement, amounted to 13,597 tons at March 31, as against 15,437 tons at the end of February, showing a further decrease in the total visible supply of 1,840 tons. Monthly supplies from all sources amounted to 8,036 tons, as against 8,725 tons for the previous month, deliveries in that period being 9,876 tons, against 9,403 tons for February. The price of standard tin during March was £284 10s., as compared with £293 10s. in February. Current quotations:—*Cash*: Thursday, £281; Friday, £279 5s.; Monday, £280 5s.; Tuesday, £279; Wednesday, £274 5s.

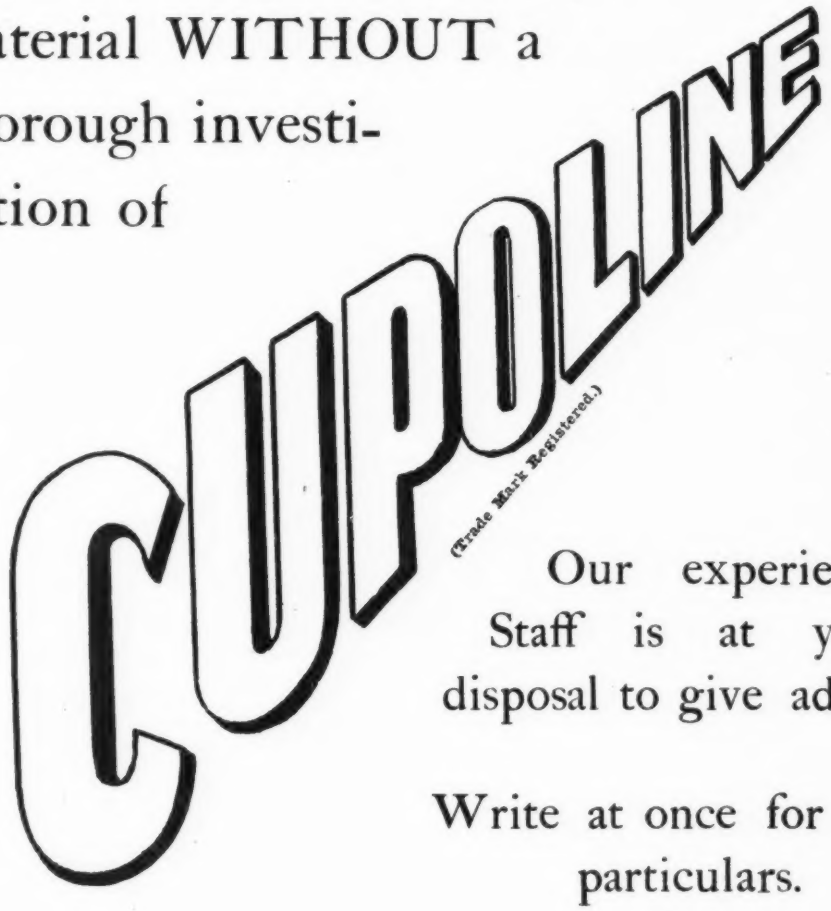
Three Months: Thursday, £270; Friday, £269 10s.; Monday, £270 15s.; Tuesday, £269 15s.; Wednesday, £268 5s.

Spelter.—Business in this metal of late may be reported steadier on the whole, quotations to date also denoting a slight improvement. There has been a better demand of late from galvanisers in this country. The American statistics for March, recently published, were looked upon as disappointing, the stocks showing an increase of 220 tons. Current quotations:—*Ordinary*: Thursday, £32 3s. 9d.; Friday, £32 3s. 9d.; Monday, £32 8s. 9d.; Tuesday, £32 11s. 3d.; Wednesday, £32 10s.

Lead.—The market for soft foreign pig has suffered a considerable relapse, values reaching £28 5s. prompt and £28 17s. 6d. forward, on the 9th inst. A fairly sharp recovery improved values about £1 a ton, the low level having led to bear covering and speculative purchases of forward. Supplies continue to be ample, and so far there are no signs of any important increase in consumption. Current quotations:—*Soft foreign (prompt)*: Thursday, £28 5s.; Friday, £28 7s. 6d.; Monday, £28 16s. 3d.; Tuesday, £28 12s. 6d.; Wednesday, £28 5s.

Mr. John Craig, chairman of David Colville & Sons, Limited, has been elected president of the West of Scotland Iron and Steel Institute.

DON'T buy refractory material WITHOUT a thorough investigation of



Our experienced Staff is at your disposal to give advice.

Write at once for full particulars.

ROBSON REFRACTORIES LTD.

1, North Road,

DARLINGTON, Durham.

Telephone: 2405. *Telegrams: Cupoline, Darlington.*

CUPOLINE STORAGE DEPOTS AT:

Middlesbrough, Leith, Newcastle-on-Tyne, Newport (Mon.), Garston, Liverpool.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	57	2	6
Three months	57	17	6
Electrolytic	64	15	0
Tough	66	0	0
Best selected	60	10	0
Sheets	90	0	0
India	74	0	0
Wire bars	65	10	0
Do. May	65	0	0
Do. June	65	0	0
Ingot bars	65	0	0
H.C. wire rods	69	10	0
Off. av. cash, Mar.	58	13	3 1/24
Do., 3 mths. Mar.	59	12	5 5/24
Do., Sttlmnt, Mar.	58	13	0 1/24
Do., Electro, Mar.	65	13	7 23/24
Do., B.S., Mar.	62	10	3½
Aver. spot price copper, Mar.	58	13	0½
Do., wire bars, Mar.	65	17	4½
Solid drawn tubes			12¾d.
Brazed tubes			12¾d.
Wire			9½d.

BRASS.

Solid drawn tubes	11¾d.
Brazed tubes	13¼d.
Rods, drawn	10⅞d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g	10½d.
Wire	9⅞d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	274	5	0
Three months	268	5	0
English	272	0	0
Bars	278	10	0
Straits	287	0	0
Australian	279	12	6
Eastern	278	5	0
Banca	279	7	6
Off. aver. cash, Mar.	292	8	6 9/24
Do., 3 mths., Mar.	283	12	11 15/24
Do., Sttlmt. Mar.	292	8	5 21/24
Aver. spot., Mar.	292	8	6½

SPELTER.

Ordinary	32	10	0
Remelted	29	15	0
Hard	26	10	0
Electro 99.9	35	17	6
English	33	5	0
India	29	0	0
Zinc dust	42	0	0
Zinc ashes	14	0	0
Off. aver., Mar.	34	3	4 10/24
Aver., spot, Mar.	34	1	9½

LEAD.

Soft foreign ppt.	28	5	0
English	29	15	0
Off. average, Mar.	31	15	5 25/24
Average spot, Mar.	31	12	6

ZINC SHEETS, &c.

Zinc sheets, English	41	0	0
Do. V.M. ex whf.	38	10	0
Rods	44	0	0
Boiler plates	38	10	0
Battery plates	38	0	0

ANTIMONY.

Special brands, Eng.	89	10	0
Chinese	75	0	0
Crude	50	0	0

QUICKSILVER.

Quicksilver	15	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon 25%	9	10	0
45/50%	11	7	6
75%	20	10	0
Ferro-vanadium— 35/40%	14/5 lb. va.		
Ferro-molybdenum— 70/75% c. free	5/10½ lb.		
Ferro-titanium— 23/25% carbonless	11½d. lb.		
Ferro-phosphorus, 20/25%,	£17	0	0
Ferro-tungsten— 80/85%, c.fr.	1/9 lb.		
Tungsten metal powder— 98/99%	2/- lb.		
Ferro-chrome— 2/4% car.	£33	10	0
4/6% car.	£22	7	6
6/8% car.	£21	15	0
8/10% car.	£20	17	6
Ferro-chrome— Max. 2% car.	£38	10	0
Max. 1% car.	£44	10	0
Max. 0.70% car.	£54	10	0
70%, carbonless	1/5½ lb.		
Nickel—99%, cubes or pellets	£170		
Cobalt metal—98/99%	10/- lb.		
Aluminium 98/99%	£112		
Metallic Chromium— 96/98%	3/3 lb.		
Ferro-manganese (net)— 76/80%, loose	£15	0	0
76/80%, packed	£16	0	0
76/80%, export	£14	5	0
Metallic manganese— 94/96%, carbonless	2/- lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. 2	d. 6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. and over 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Do. under ¼in. to ⅛ in. 1/- lb.
Flats, ½in. × ½in. to under 1 in. × ¾ in. 3d. lb.
Do. under ½in. × ½in. 1/- lb
Bevels of approved sizes and sections 6d. lb.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.

Per lb. net, d/s steel makers' work

SCRAP.

South Wales—	£	s.	d.	£	s. d.
Hvy. steel	3	7	6	to 3	10 0
Bundled steel & shrngs.	3	2	6	to 3	7 6
Mixed iron & steel	3	1	6	to 3	3 6
Heavy cast iron	3	2	6	to 3	5 0
Good machinery for foundries	3	7	6		
Cleveland— Heavy steel	3	2	6		
Steel turnings	2	6	0		
Cast iron borings	2	4	0		
Heavy forge	4	2	6		
Bushelled scrap	3	7	6		
Cast-iron scrap	3	5	0		
Lancashire— Cast-iron scrap	3	5	to 3	10	0
Hvy. wrought	3	5	0		
Steel turnings	2	2	0		

London — Merchants' buying prices delivered yard.

Copper (clean)	49	0	0
Brass (clean)	38	0	0
Lead (less usual draft)	25	10	0
Tea lead	21	0	0
Zinc	24	0	0
New aluminium cuttings	80	0	0
Braziery copper	45	0	0
Gunmetal	41	0	0
Hollow pewter	176	0	0
Shaped black pewter	130	0	0

PIG-IRON.

(*f.o.t. unless otherwise stated*).

N.E. Coast— Foundry No. 1	72/6
Foundry No. 3	70/-
Foundry No. 4	69/-
Forge No. 4	68/-
Hematite No. 1	76/6
Hematite M/Nos.	76/-
N.W. Coast— Hem. M/Nos. d/d Glas.	85/3
„ d/d Birm.	93/-
Midlands— Staffs common*	—
„ No. 4 forge	62/6
„ No. 3 foundry	67/6
Shrops. basic	70/-
„ Cold blast, ord.*	185/-
„ „ roll iron*	190/-
* d/d Birmingham.	
Northants forge	56/6
„ fdry No. 3	63/3
Derbyshire forge	60/6
„ fdry. No. 3	67/6
„ basic	65/-
Scotland— Foundry No. 1	81/-
„ No. 3	76/-
Hem. M/Nos.	76/-
Sheffield (d/d district)— Derby forge	65/-
„ fdry. No. 3	71/6
Lincs. forge	67/6
„ fdry. No. 3	70/-
E.C. hematite	87/-
W.C. hematite	89/-
Lincs. (at furnaces)— Forge No. 4	61/6
Foundry No. 3	64/-
Basic	63/-
Lancashire (d/d eq. Man.)— Derby forge	68/-
„ fdry. No. 2	75/3
Northants foundry No. 3	76/-
Dalzell, No. 3	110/-
Summerlee, No. 3	93/6
Glengarnock, No. 3	93/6
Gartsherrie, No. 3	93/6
Monkland No. 3	93/6
Coltness, No. 3	93/6
Shotts, No. 3	93/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	11	0	0	to 12	0	0
Angles				11	10	0
Tees to 3 united ins.				12	0	0
Nut and bolt	10	5	0	to 10	7	6
Hoops	14	0	0	to 15	0	0
Marked bars (Staffs.) f.o.t.				14	0	0
Gas strip				12	10	0
Bolts and nuts ¾ in. × 4 in.				15	5	0
Steel— Ship plates	7	12	6	to 7	17	6
Boiler plts.				11	5	0
Chequer plts.				9	15	0
Angles	£7	2	6	to 7	5	0
Tees	£8	2	6	to 8	5	0
Joists	£7	2	6	to 7	5	0
Rounds and Squares 3 in. to 5½ ins.				7	15	0
Rounds under 3 in. to ¾ in.				7	10	0
Flats, over 5 in. wide and up				8	5	0
Flats, 5in. to 1½in.				7	5	0
Rails, heavy				8	0	0
Fishplates				12	0	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				11	2	6
Galv. cor. sheets, 24g.	15	5	0	to 15	10	0
Galv. fencing wire 8g. plain				13	0	0
Billets, soft	£6	2	6	to 6	5	0
Billets, hard				8	2	6
Sheet bars	6	0	0	to 6	2	6
Tin bars d/d	6	2	6	to 6	5	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3¾
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled— To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round— 3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	23.26
No. 2 foundry, Valley	20.76
No. 2 foundry, Birm.	22.00
Basic	20.26
Bessemer	21.26
Malleable	20.76
Grey forge	20.26
Ferro-mang. 80% d/d	88.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.50
Sheets, black, No. 28	3.25
Sheets, galv., No. 28	4.50
Sheets, blue an'l'd, 9 & 10	2.40
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb box	$5.50

COKE (at ovens).

Welsh foundry 32/6 to 40/-
„ furnace 20/- to 25/-
Durham & North.
„ foundry 30/- to 33/-
„ furnace 14/6 to 15/-
Other Districts, foundry 30/- to 33/-
„ „ furnace (basis) 11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes, 20×14, box		19/3
„	28×20, „	38/6
„	20×10, „	29/-
„	18¾×14, „	20/4½
C.W.	20×14, „	17/4½
„	28×20, „	34/9
„	20×10, „	23/10½
„	18¾×14, „	18/1½

Terneplates 28×20, 35/6 per box basis f.o.b.

SWEDISH IRON.

Bars, hammered £18/10 to £19/0
Rolled Ord. £15/15/0 to £16/5/0
Nail rods £16 5 0 to £16 15 0
Keg. steel nom. £33 to £35
Faggot steel nom. £22 to £25
Blooms, according to quality £9 to £12
Pig-iron £6 5 0 to £7 0 0 all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes	*Fittings*
Gas ..	60%	.. 50%
Water ..	55%	.. 45%
Steam ..	50%	.. 40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

		£	s.	d.	
Apr.	22	57	0	0	dec. 12/6
,,	23	57	0	0	No change
,,	26	57	10	0	inc. 10/-
,,	27	57	5	0	dec. 5/-
,,	28	57	2	6	,, 2/6

Electrolytic Copper.

		£	s.	d.	
Apr.	22	64	10	0	No change
,,	23	64	10	0	,, ,,
,,	26	65	0	0	inc. 10/-
,,	27	65	0	0	No change
,,	28	64	15	0	dec. 5/-

Standard Tin (Cash).

		£	s.	d.	
Apr.	22	281	0	0	inc. 40/-
,,	23	279	5	0	dec. 35/-
,,	26	280	5	0	inc. 20/-
,,	27	279	0	0	dec. 20/-
,,	28	274	5	0	,, 95/-

Tin (English ingots).

		£	s.	d.	
Apr.	22	279	0	0	inc 40/-
,,	23	277	5	0	dec. 35/-
,,	26	278	0	0	inc. 15/-
,,	27	276	10	0	dec. 30/-
,,	28	272	0	0	,, 90/-

Zinc Sheets (English).

		£	s.	d.	
Apr.	22	41	0	0	No change
,,	23	41	0	0	,, ,,
,,	26	41	0	0	,, ,,
,,	27	41	0	0	,, ,,
,,	28	41	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Apr.	22	32	3	9	inc. 6/3
,,	23	32	3	9	No change
,,	26	32	8	9	inc. 5/-
,,	27	32	11	3	,, 2/6
,,	28	32	10	0	dec. 1/3

Lead (English).

		£	s.	d.	
Apr.	22	29	15	0	inc. 5/-
,,	23	30	0	0	,, 5/-
,,	26	30	5	0	,, 5/-
,,	27	30	5	0	No change
,,	28	29	15	0	dec. 10/-

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

	Jan.			Feb.			March			April			May			June			July			Aug.			Sept.			Oct.			Nov.°			Dec.			Yearly average		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1901	13	0	0	12	5	0	11	10	0	11	16	0	11	10	0	11	10	0	11	10	0	11	10	0	11	10	0	12	0	0	12	0	0	12	0	0	11	17	1
1902	12	0	0	11	10	0	11	10	0	11	10	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	14	2
1903	11	5	0	11	5	0	11	5	0	11	10	0	11	10	0	11	10	0	11	10	0	11	10	0	11	5	0	11	5	0	11	5	0	11	5	0	11	7	1
1904	11	5	0	11	5	0	11	5	0	11	5	0	10	15	0	10	15	0	10	15	0	10	15	0	10	5	0	10	5	0	10	5	0	10	5	0	10	15	0
1905	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	11	0	0	11	5	0	11	15	0	12	0	0	11	15	0
1906	12	12	6	12	12	6	12	12	6	12	7	6	12	7	6	12	7	6	12	12	6	12	12	6	12	15	0	12	15	0	12	15	0	13	5	0	12	12	11½
1907	13	5	0	13	5	0	13	15	0	13	15	0	13	15	0	13	15	0	13	17	6	13	17	6	13	17	6	13	2	6	13	2	6	13	2	6	13	10	10
1908	13	2	6	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	11	0½
1909	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	11	0	0	11	0	0	11	0	0	11	0	0	11	16	8
1910	11	15	0	12	5	0	12	5	0	11	15	0	11	10	0	11	10	0	11	12	6	11	12	6	11	12	6	11	12	6	11	10	0	11	10	0	11	13	4
1911	11	5	0	11	1	3	10	15	0	10	15	0	10	13	9	10	10	0	10	13	9	11	0	0	11	5	0	11	5	0	11	5	0	11	7	0	10	19	7½
1912	11	10	0	11	10	0	11	10	0	11	15	0	12	5	0	12	5	0	12	5	0	12	5	0	12	5	0	12	5	0	12	12	6	12	18	0	12	15	0	12	2	11½
1913	12	15	0	12	15	0	12	15	0	12	11	3	11	18	0	11	15	0	11	15	0	11	15	0	11	15	0	11	3	0	11	0	0	11	2	6	11	18	4
1914	11	7	0	11	7	6	11	7	6	11	5	7½	11	2	6	10	15	0	10	15	0	10	15	0	12	17	6	14	2	0	13	7	0	11	15	7	11	2	6	11	16	0
1915	11	10	8½	13	12	6	14	8	9	15	0	6	17	17	6	20	17	6	20	17	6	20	6	3	17	12	6	18	1	0	22	13	9	25	2	0	18	3	4½
1916	26	5	0	27	12	6	28	0	0	28	5	0	29	0	0	29	0	0	28	15	0	28	3	0	28	15	0	28	15	0	28	15	0	28	15	0	28	6	8½
1917	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	0	0	28	0	0	28	0	0	28	11	3
1918	28	5	0	28	15	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	28	13	4
1919	29	0	0	29	0	0	29	0	0	28	0	0	28	10	0	27	7	6	27	5	0	29	3	0	32	0	0	33	0	0	36	10	0	40	8	4	31	5	3½
1920	46	10	0	49	15	0	53	15	0	56	0	0	55	10	0	54	10	0	52	10	0	48	10	0	44	3	4	39	2	6	35	17	6	30	8	0	47	4	3
1921	28	10	0	25	17	6	24	5	0	23	3	4	22	0	0	22	0	0	23	10	0	21	12	6	20	0	0	18	15	0	18	3	9	17	2	0	22	1	7
1922	16	17	6	15	13	9	16	3	0	16	10	0	16	4	4½	15	15	6	15	16	3	16	16	0	16	8	9	16	6	3	17	1	0	17	7	6	16	7	5½
1923	18	3	1¼	19	1	11½	19	8	0	19	10	0	19	7	0	19	1	3	18	0	0	18	13	1¼	19	0	0	19	3	9	19	2	6	18	19	4½	18	19	2
1924	18	13	6	18	9	4½	18	5	0	17	15	11½	17	3	0	17	19	4½	18	7	6	18	8	1½	18	8	1½	17	19	6	17	11	3	17	10	0	18	0	10½
1925	17	8	6	17	1	6½	16	9	4½	16	12	0	16	9	8¼	16	9	4½	16	0	6	16	1	10½	16	5	0	16	7	0	16	12	6	16	15	0	16	11	0½
1926	16	14	4½	16	5	7½	16	0	6	15	13	4	—			—			—			—			—			—			—			—			—		

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

93, HOPE STREET, GLASGOW.

ROYAL EXCHANGE, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED.

CHEMIST and METALLURGIST (38), technically trained, desires situation; 20 years' Steel Foundry experience in control of Lab., Tropenas and Electric Furnace; results assured; good references.—Box 706, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER or FOREMAN; thoroughly practical Foundryman desires change; wide experience all classes of high-grade castings in grey iron or malleable; good references.—Box 708, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ROLL CASTER.—Wanted, for large Foundry on Continent, experienced Roll Caster for Chilled and Grain Rolls.—Apply in first instance, giving full particulars, to Box 293, c/o JOHN HART & COMPANY, 6, Arundel Street, Strand, W.C.2.

METALLURGIST (28) requires responsible and progressive appointment as Metallurgist or Foundry Manager; eight years' experience in control of metal mixing, melting, and testing, for the production of motor (especially cylinders) and engineering castings in grey iron, "semi-steel," malleable, and non-ferrous (aluminium, etc.) alloys; also malleable annealing practice, general metallurgical and laboratory supervision.—Box 712, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PRACTICAL Steel Foundry Metallurgist desires position; could erect successful small steel plant, or invest limited amount with small firm; present position Steel Foundry Manager.—Box 714, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WORKING FOREMAN wanted for a small Foundry near London; must be a thoroughly competent man.—State full particulars, experience and wages required to Box 710, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

TRAVELLERS, calling on Engineers, Ironfounders and similar trades, wanted to sell side line on commission.—Write, giving full particulars, present lines, ground covered, age, references, to Box 13, MATHER & CROWTHER, LIMITED, 10, New Bridge Street, London, E.C.4.

IRON MOULDERS AND COREMAKERS.—Old-established firm in the Midlands has numerous vacancies for men for Loam and Dry Sand work on high-grade work.—Apply, stating age, full details of experience and wages required, to Box No. 704, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

EX-OFFICERS AND OTHER RANKS.

The Proprietors of the FOUNDRY TRADE JOURNAL have placed this space at the disposal of the British Legion, Officers' Association, Employment Bureau, 3-4, Clement's Inn, Strand, London, W.C.2. (telephone: Holborn 5769), to whom all replies should be addressed, quoting number of advertisement, date on which it appeared, and the name of this paper.

EX-OFFICER, with general commercial and engineering training, desires Secretarial work; book-keeping and staff control; energetic; thoroughly trustworthy and reliable; open to accept any position at a moderate salary at home or abroad. (Dis. 48)

PATENTS.

PATENT YOUR INVENTIONS, Trade-mark your Goods. Advice, Handbook and Cons. free.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 38 years' refs. 'Phone 682 Central.

MACHINERY

WANTED, Cut Wire Machine; say greatest thickness of steel sheet it will cut, output per hour, lowest price, where it can be seen; send drawing or photo.—MCCLINTON'S, LIMITED, Donaghmore, Tyrone.

10-TON DENISON CRANE HOOK, suspension type, Weighing Machine.—FYFE, WILSON & COMPANY, LIMITED, 31, Budge Row, E.C.4.

FOR SALE, one 400-lb. Morgan Oil Fired Tilting Furnace, good condition, with Blower, Tank, and necessary Piping; also about 50 Pots for same.—Apply, THE FORDATH ENGINEERING COMPANY, LIMITED, Hamblet Works, West Bromwich.

MACHINERY.—*Continued.*

FOR SALE, Cupola Fan and Motor (direct coupled), complete with starter; complete unit in excellent condition, suitable for melting up to 3 tons per hour; full specifications on application; low price for quick sale.—Write, LAWSON, WALTON & COMPANY, LIMITED, Newcastle/Tyne.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

CUPOLA, Fan, Ladles, Crucibles, Carriers, Tongs, Direction Post Patterns with Boxes, 2-ton Travelling Crane with uprights; particulars sent on request; reasonable offers accepted.—FISHER & SWAIN, Engineers, Yeovil.

MACHINERY, PLANT, &c.

HORIZONTAL STEAM-DRIVEN AIR COMPRESSOR, 14-in. steam cyl., 14-in. air, 16-in. stroke, by American Well Works Company.

SENTINEL AIR COMPRESSOR, 260 cub. ft. capacity at 100 lbs. pressure, driven by 55-h.p. Motor, 500 volts.

HORIZONTAL BELT-DRIVEN AIR COMPRESSOR, 15-in. cyl., 11-in. stroke, 448 cub. ft. capacity at 70 lbs., by Robey.

BELT-DRIVEN SINGLE STAGE QUADRUPLEX AIR COMPRESSOR, by Reavell, capacity 330 cub. ft. at 80/100 lbs. pressure.

FOUR LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 150 lbs. pressure.

TWO LOCO. TYPE BOILERS, 11 ft. 6 in. long, barrel 2 ft. 8 in. diam., reinsure 170 lbs. pressure.

CATALOGUE (10,000 LOTS) ON APPLICATION.

THOS W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

LETTERS AND FIGURES for Patterns; all sizes; Aluminium; die cast, with pins in one piece; no shellac needed; simply drive them in and they cannot come off. Send for samples and prices.—A. LAKIN & SON, Totley Rise, Sheffield.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. Phone 264.

SHOVELS AND FORKS.—For all sizes and styles write LAWSON, WALTON & Co., LTD., Newcastle/Tyne.

FOUNDRY BRUSHES, all kinds; Steel Wire Brushes, Tube Brushes, and Boiler Scale Brushes.—WILLIAM OLSEN, LIMITED, Cogan Street, Hull.

HAVE YOU HAD YOUR COPY?—FREE!
A Handbook of Practical Information for
FOUNDRYMEN AND ENGINEERS
Published by:—
BEECROFT & PARTNERS, Ltd., ST. PETER'S CLOSE, SHEFFIELD
(Consulting Metallurgical and Foundry Chemists)
Sent post free upon written application

66" **CUPOLA,** by THWAITES, drop bottom, been little used; 10 tons per hour at BLACKBURN £150
ELECTRIC BLOWER by KEITH-BLACKMAN, 12" outlet, with 19 h.p. variable speed motor and starter for above cupola £50
48" **CUPOLA,** by THWAITES, as above, but no spark arrester at BLACKBURN £90
30" **CUPOLETTE,** by CONSTRUCTIONAL CO., with pipes and fan complete... ... ... £32

NEW LADLES—CHEAP.

12 Ton EVANS £95
5 Ton McNEIL £38
3 Ton THWAITES £32
2½ Ton by GEORGE GREEN £30
2 Ton THWAITES £26

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND. *FOUNDRY MACHINERY MERCHANT.*
14, AUSTRALIA ROAD, SLOUGH.

XUM